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ON

DISEASES AND INJURIES

OF

THE EYE

ON

DISEASES AND INJURIES

OF

THE EYE

A COURSE OF SYSTEMATIC AND CLINICAL LECTURES TO STUDENTS AND MEDICAL PRACTITIONERS

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BY

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PREFACE

THIS work is published in fulfilment of a promise, which I have repeatedly made to my students for some years back, to furnish them with a *resumé* of the Courses of Lectures delivered in Anderson's College and at the Glasgow Ophthalmic Institution. These have been so arranged as to form a complete practical treatise on diseases and injuries of the eye.

In a branch of science, such as Ophthalmology, which has been progressing so rapidly of late years under the labours of many eminent workers, text-books very soon fall out of date, and therefore no apology seems to be requisite for putting before the profession a treatise of this nature, in which every effort has been made to embody the latest investigations in as brief and comprehensive a style as possible, with the view of rendering it useful and interesting reading to those who have not studied Ophthalmology as a separate science.

So long as the study of diseases of the eye forms no officially recognized part of a medical curriculum, such a mode of teaching this branch of science seems to me likely to be most serviceable.

The chromo-lithographic illustrations have been painted for this work by my excellent and esteemed friend, Dr Hugo Magnus, Lecturer on Ophthalmology in the University of Breslau, whose labours in this department are well known and highly appreciated. Our object has been to give, for every disease of the fundus, a typical picture true to nature, and he has spared no pain in the realistic execution of the work.

18, Brandon Place,
Glasgow; *December*, 1881.

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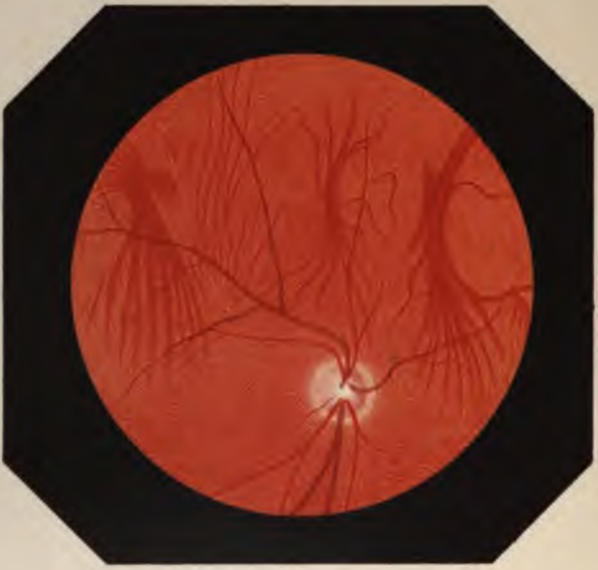
ERRATA.

Page 3, in footnote. *For* Organologied es, *read* Organologie des.
„ 91, line 20. *For* σταφηλωμα, *read* σταφυλωμα.
„ 195, line 25. *For* one, *read* 1.

Normal Fundus Oculi.

Fig. 1.



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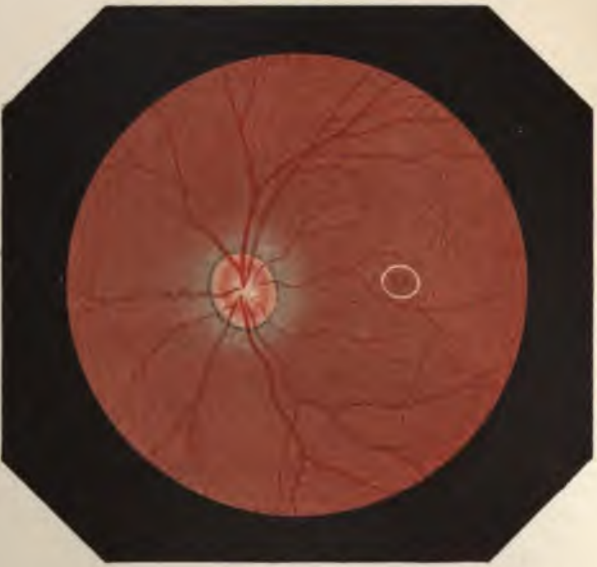
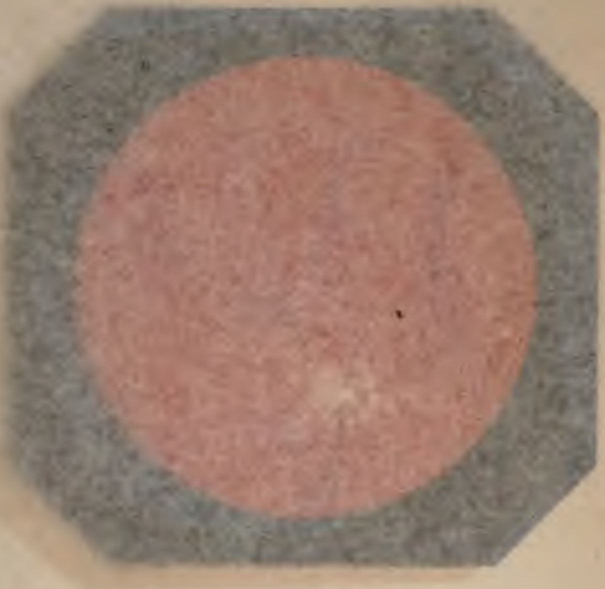


Fig. 1. Taken from the Eye of a pe[illegible]th light hair and blue irides.
Fig. 2. From a person with [illegible] and dark brown irides.

Lith. Anst. v. J.

Normal Fundus Oculi Pl

Fig. 1.



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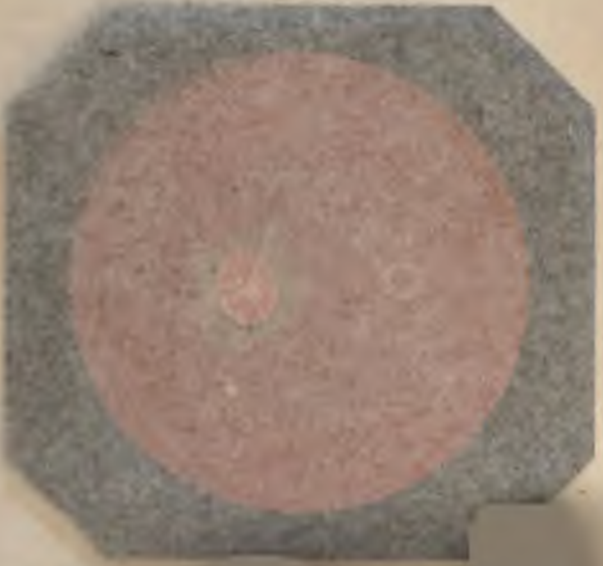

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PLATE I

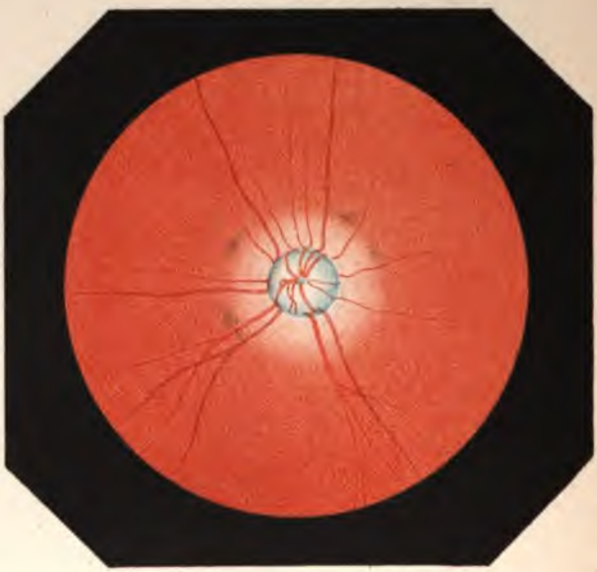
NORMAL FUNDUS OCULI

FIG. 1 is the left eye of a boy, aged thirteen, with yellowish blonde hair, and pale blue irides. The colour of the fundus is bright red, caused by marked deficiency of pigment of the choroid as well as of the epithelium. In the inverted image we see in the upper half of the fundus broad, highly-coloured vascular stroma trunks, which terminate in the form of pencils of numerous fine vessels. These are the vasa vorticosa, which are visible in relief on account of the poverty of pigment. The papilla of the optic nerve, or optic disc, is of normal form and colour. The retinal vessels are, on account of their different colour, very distinctly separated into arteries and veins. The veins have a dark, red-brown colour; the arteries have a bright brick-red colour.

FIG. 2 is the right eye of a woman, aged thirty-five, a very dark brunette. The fundus presents a dark-red colour, inclined to brown. Round the normally coloured optic disc there is a grey zone, which gradually shades off into the red of the background, and is caused by a thickening of the retina in this place. A slight dark pigmentation is drawn round the nasal side of the disc. The retinal vessel are normal in their course, and are distinctly separated into veins and arteries. The two principal trunks, which are directed upwards, branching towards the temporal side of the fundus, are designated by Magnus, arteriæ et venæ temporalis superior; the corresponding vessels of the lower half of the fundus arteriæ et venæ temporalis inferior; those which go to the macula arteriæ macularis superior et inferior. The inner part of the retina has in its upper half the arteria et vena nasalis, superior et inferior. At the temporal side of the disc there is a whitish circle, in the centre of which there is a bright spot, surrounded by a dark red zone. This is the macula lutea. The white circle is not of frequent occurrence, and is generally fainter than in figure.

Glaucoma.

Fig.1.



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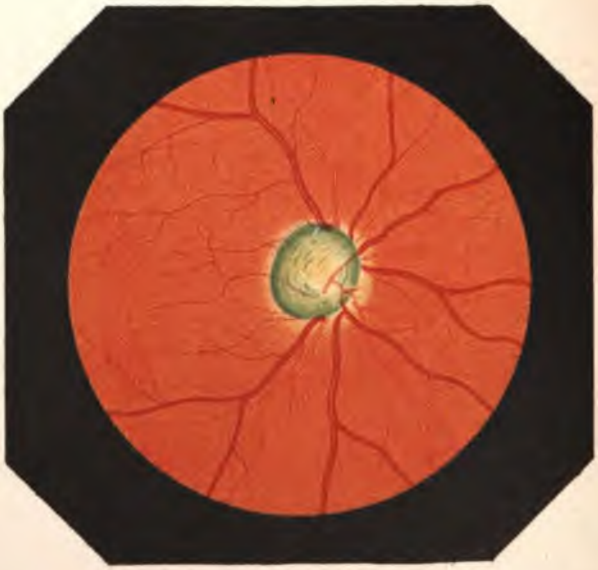

Fig.1. Glaucomatous excavation with atrophy of the choroid round the optic di

Fig.2. Glaucomatous excavation.

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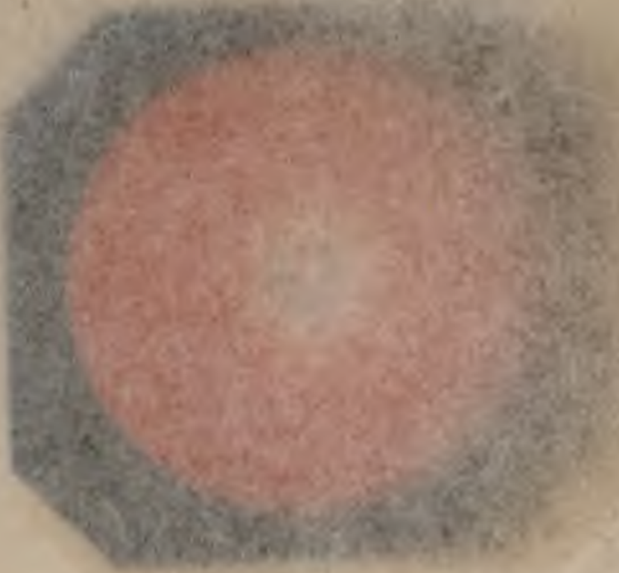
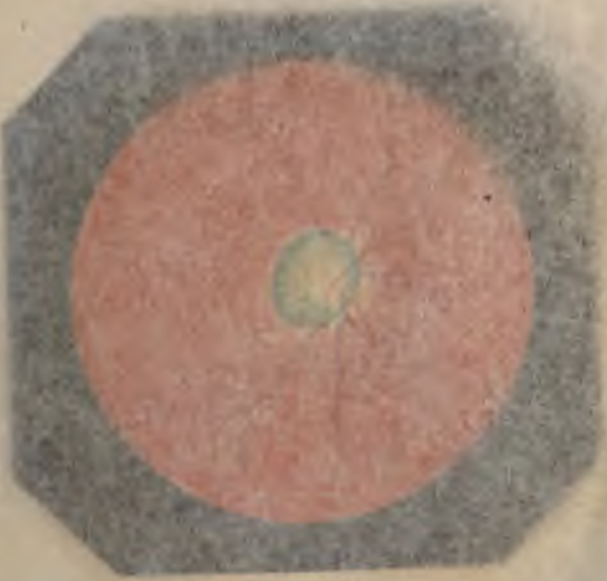




[illegible] excavation with atropy [illegible]

[illegible] excavation.

PLATE II

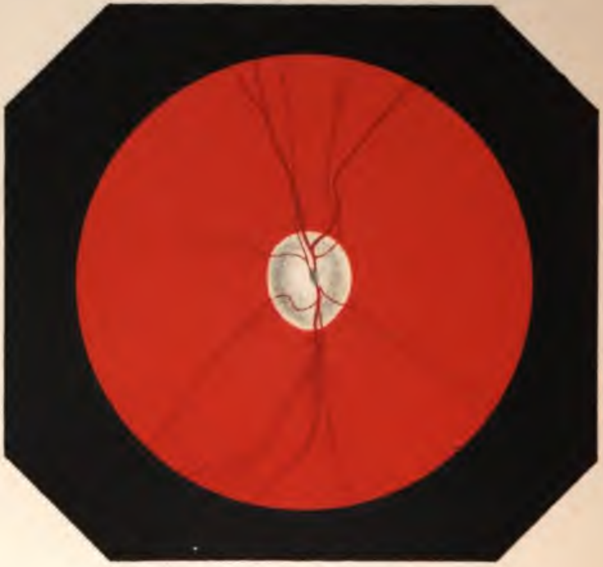
GLAUCOMA

FIG 1.—Deep excavation of the optic disc in glaucoma simplex. The disc has a bluish colour, which shows more particularly along the border; surrounding it there is a tolerably broad, clear zone, which passes gradually into the normal red of the fundus, with brown pigment spots at its termination. This clear zone corresponds to atrophy of the choroidal stroma, the result of strong intra-ocular pressure. The retinal vessels run close round the border of the disc, and look as if suddenly interrupted upon the disc. They descend with a hook-shaped curve into the depth of the excavation. Upon the floor of the disc there are numerous vessels, which meet in one point. Their colour is a clear red, and their differentiation into arteries and veins is impossible.

FIG. 2.—Glaucomatous excavation in the right eye of a woman, aged sixty-three. Here, also, there is a bright atrophied ring round the disc, which is of an irregular oval form, yellowish-white in the centre, but becoming towards the border of a distinct bluish-green. Isolated bluish-green streaks and spots can be observed upon the disc. The retinal vessels, which are of normal size, terminate, as in Fig. 1, at the margin of the disc in the form of a hook. On the floor of the excavation very small, solitary, vascular trunks are visible.

Atrophy.

Fig. 1.



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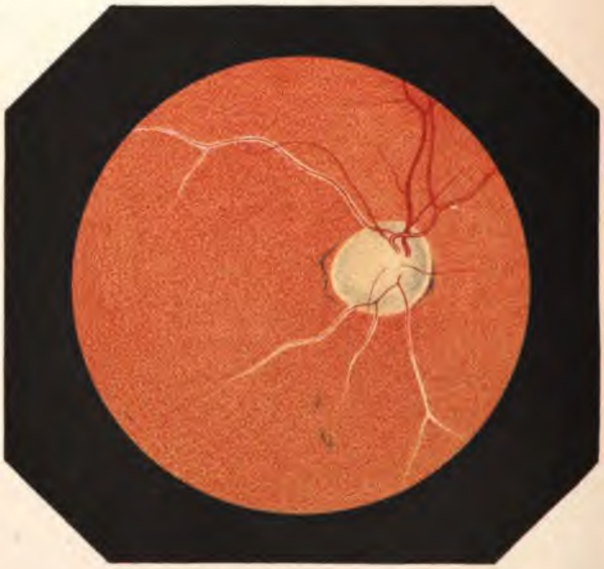

Fig. 1. Atrophy of the optic nerve.
Fig. 2. Atrophy of the optic nerve and retina.

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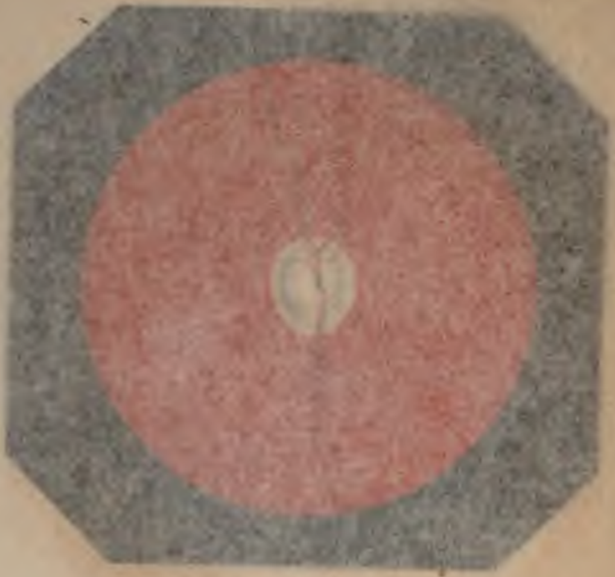
Atrophy.

Fig. 1.



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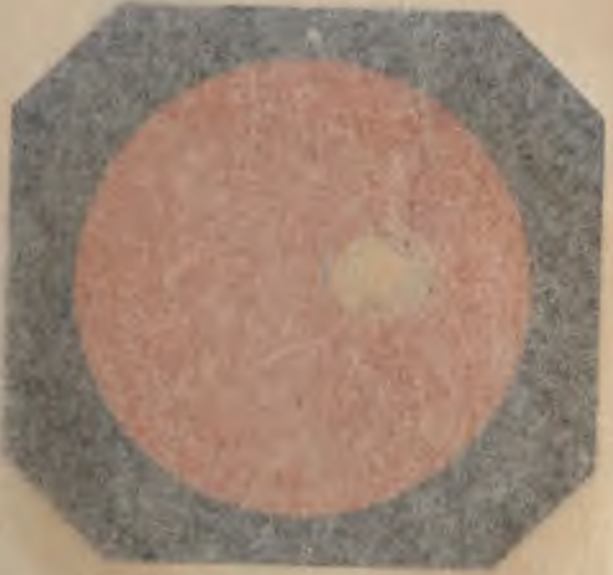

Fig. 1. Atrophy of the optic nerve.
Fig. 2. Atrophy of the optic nerve and retina.

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PLATE III

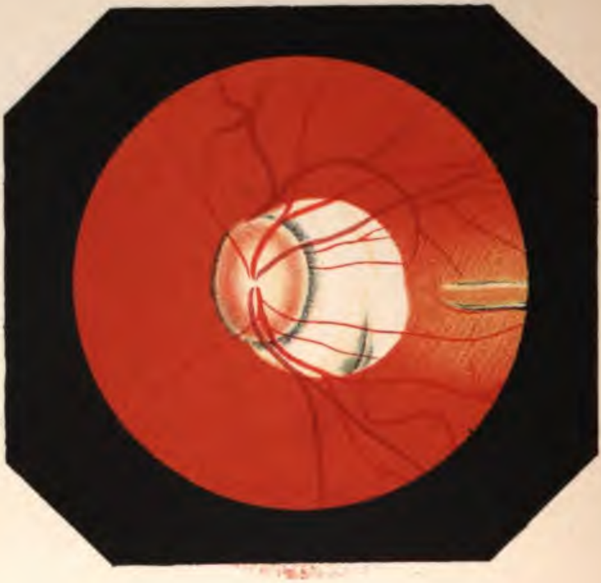
ATROPHY

FIG. 1.—Atrophy of the optic nerve in the case of an old man affected with disease of the spine (tabes dorsalis). The disc is porcelain white, with a ring of grey blue. The retinal veins are of about normal calibre, while the arteries are considerably thinned. The red of the fundus is normal.

FIG. 2.—Atrophy of the retina and optic nerve in the case of a woman, aged forty-six. The fundus is of a yellowish-red, paler than usual. The disc, of irregular form, has some black pigment streaks at its border. In the central portion it is of yellowish-white colour, but towards the periphery takes on a bluish shade. The retinal vessels are considerably diminished in number, being represented merely by the principal trunks. The arteries and veins, which run upwards, are normally full and pursue a normal course. The arteria and vena macularis inferior are considerably thinner, with narrow whitish stripes at their edges. The vena temporalis inferior is equally narrowed, and has the same white stripes. The arteria temporalis inferior is so strongly atrophied that only upon the disc can a vestige of it be discerned.

Posterior Staphyloma.

Fig.1.



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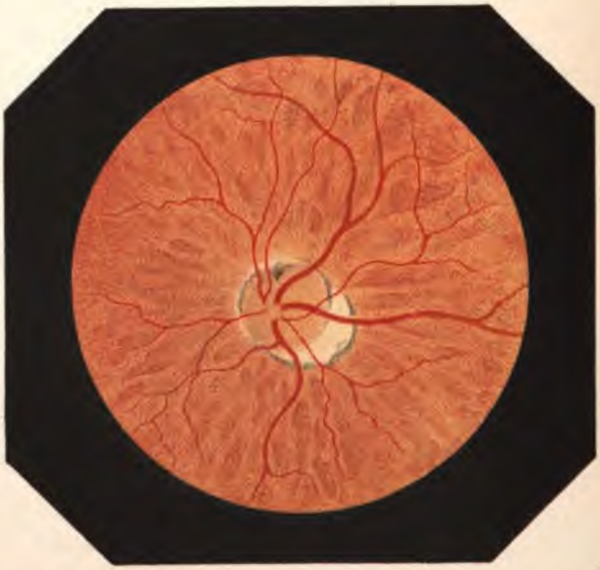

Fig. 1. Posterior Staphyloma.

Fig. 2. Posterior Staphyloma with pigmentous deposit.

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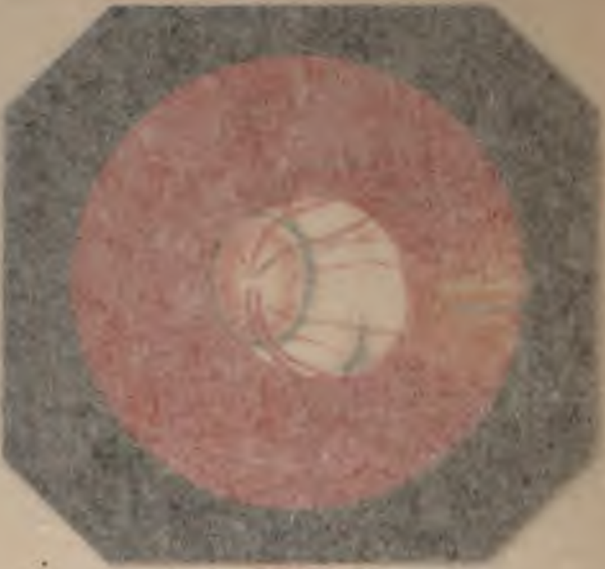
Posterior Staphyloma.

Fig. 1.



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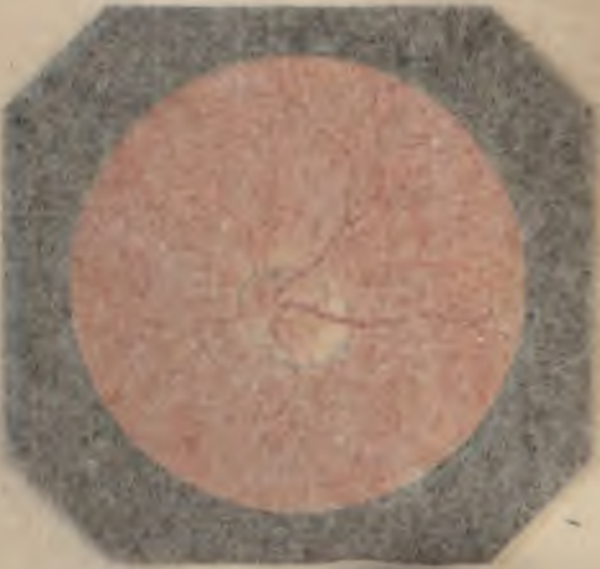


[illegible] Posterior Staphyloma [illegible]

[illegible] Posterior Staphyloma [illegible] deposit

PLATE IV

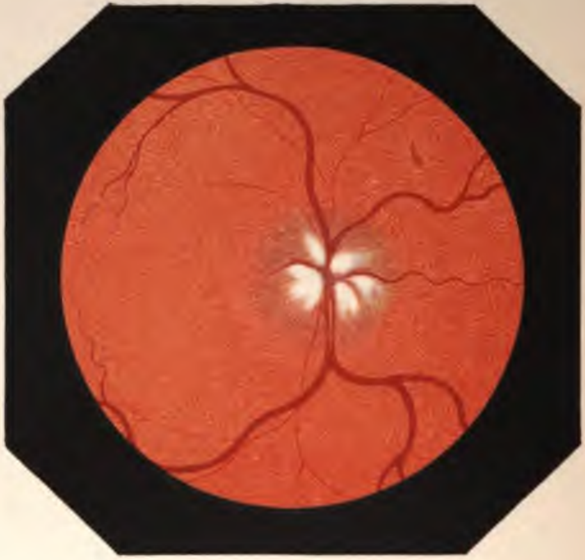
POSTERIOR STAPHYLOMA

FIG. 1.—Right eye of a woman, aged thirty-two. The disc is of a normal colour and oval shape, with a long vertical axis. At its macular side there is a white, irregularly shaped crescent, surrounding half of the circumference of the disc, and with a sharp, clear outline. The macular edge of the disc is surrounded by a grey-black border. Some stripes and spots of the same colour are observed upon the white crescent. The fundus presents the normal red appearance, but its colour in the macular region becomes of a brighter yellowish-red. There are also here two greyish-white stripes. Exactly above the disc, in the inverted image, there are the dark red choroidal vessels, over which pass the arteria and vena temporalis.

FIG. 2.—A small lower staphyloma, with pigmentous deposit upon the disc. The fundus shows a brighter yellowish red, with numerous insular spots of greyish red. The disc is normal both in form and colour, and also the arteries and veins. The disc is surrounded by a whitish zone, the breadth of which is not uniform, but considerably greater towards the temporal side of the disc. This broader portion has a black pigment fringe. Pigment spots are also found upon the disc near its nasal border.

Optic Neuritis.

Fig.1.



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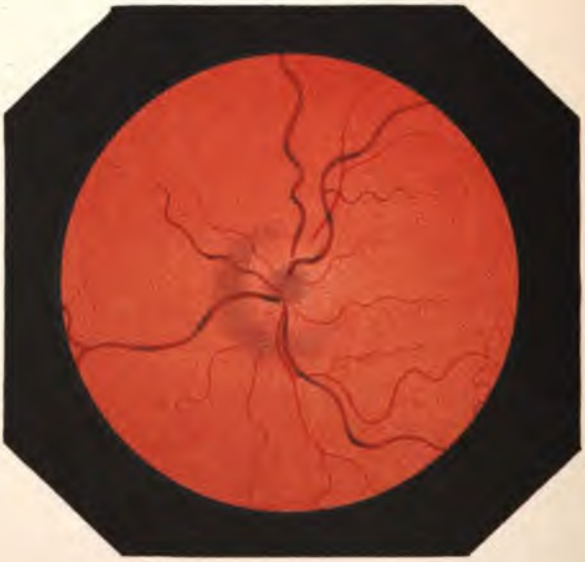

Fig. 1. Stauungspapilla in basilar meningitis.
Fig. 2. Stauungspapilla in disease of the cerebrum and dura mater.

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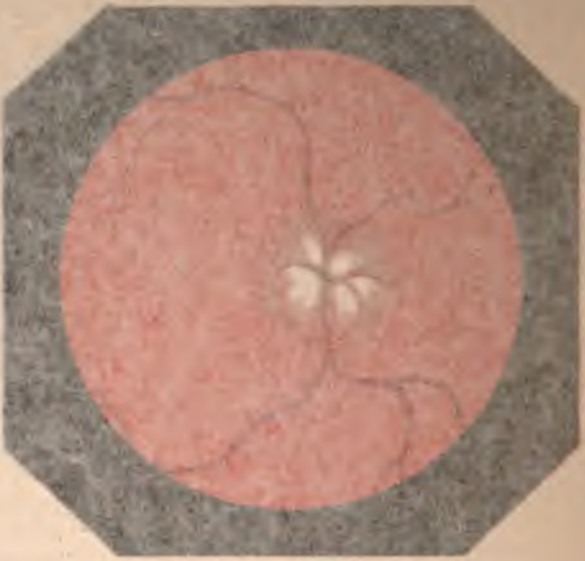
Optic Neuritis.

Fig. 1.



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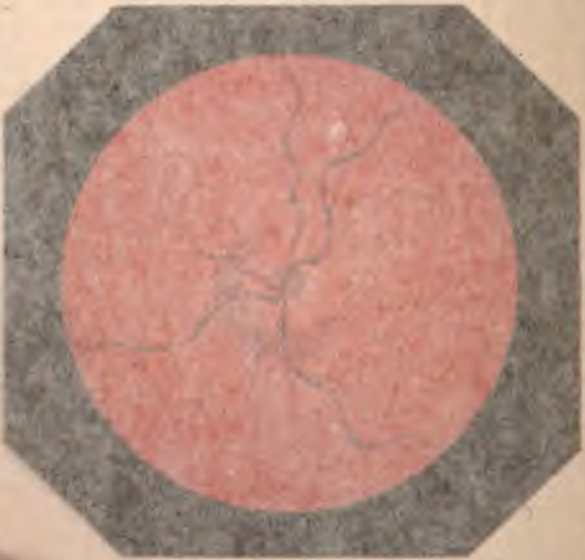

[illegible] papilla in basilar meningitis.

[illegible] papilla in disease of the cerebrum and dura mater.

PLATE V

OPTIC NEURITIS

FIG. 1.—Staungspapilla of the left eye, in basilar meningitis. The border of the disc is totally obliterated, so that there is no sharp contour on any side. The colour is a dirty grey blue, with isolated shining white spots. The colour of the rest of the fundus is of the usual red. The retinal arteries are extremely thin, like fine threads, so that they can scarcely be recognised on the disc. The retinal veins, on the other hand, are swollen, more tortuous than usual, and of a dark-red colour. The principal inferior venous trunk in the inverted image has a very marked white reflection.

FIG. 2.—Staungspapilla of the right eye, in disease of the brain and dura mater. The disc is perfectly obliterated, so that no trace of its border is discernible, is of a pale yellowish-red colour, which gradually loses itself in the normal red of the fundus. The retinal veins show striking tortuosity, with a sharp, bow-like curve, where they are seen against the swollen disc. At these curves there is found a very dark brown-red colouration, while in the other parts of their course they are of a cherry brown, and not so intense as at the curves. The calibre of the veins is considerably increased, while the retinal arteries are very much thinner than normal.

Optic Neuritis.

Fig.1.

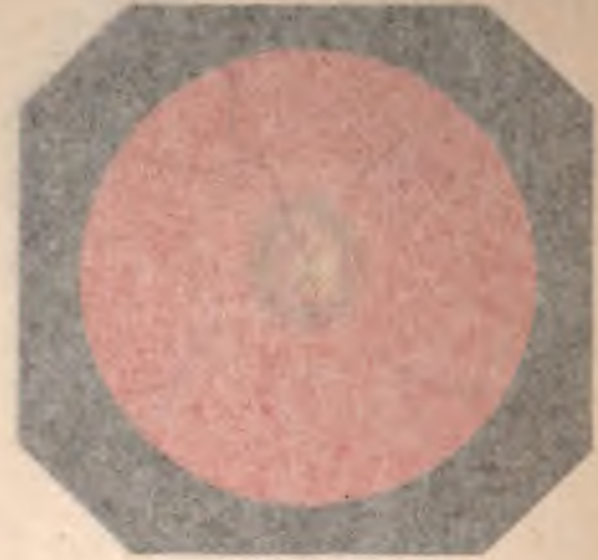

Fig. 2.

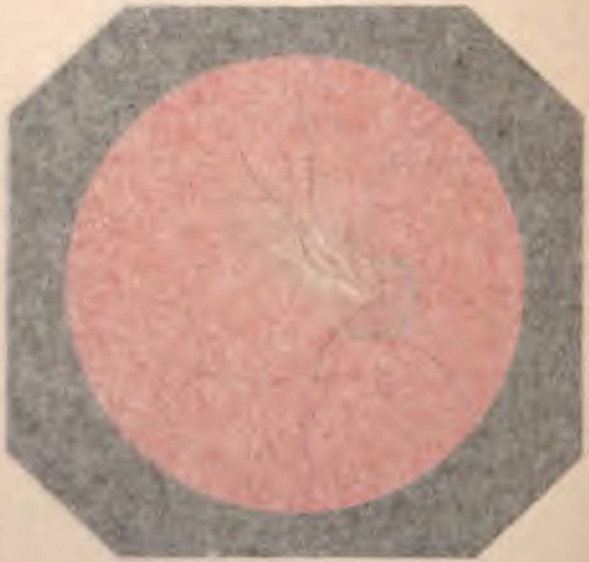

Fig.1. Optic Neuritis in tumor cerebri.
Fig.2. Neuro-retinitis.

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PLATE VI

OPTIC NEURITIS

FIG. 1.—Inflammation of the optic nerve in tumour of the brain. The disc is of a yellowish-grey colour. Its border can be recognised, but is strongly veiled by a greyish colour, which gradually shades off into the normal colour of the fundus. The retinal veins are in some parts more tortuous than usual, especially on the disc, where some of them have a serpentine look. The colour of the veins is a dark cherry red, but is less pronounced on the border of the disc and appears here as if covered with a veil. The retinal arteries are thinner than normal, and in some cases can be discerned only by very careful examination.

FIG. 2.—Disease of the retina and optic nerve, which is confined to one quadrant of the fundus. The disc is of normal form and colour, and only in its upper temporal part is thickened by a yellowish-grey coloured veil, which stretches far into the fundus and gradually disappears on the background towards the periphery, where it passes into the natural red. Close by and upon the disc this colouration is more clearly seen, as it presents itself in this place in a pronounced pale grey yellow. Towards the periphery the colour assumes more a **grey-red tint. The retinal vessels are veiled by the exudation which has been called forth.**

Retinitis.

Plat

Fig. 1.

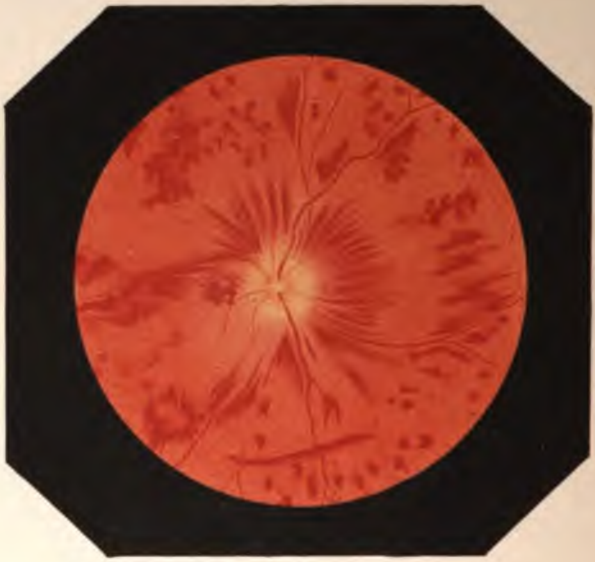

Fig. 2.

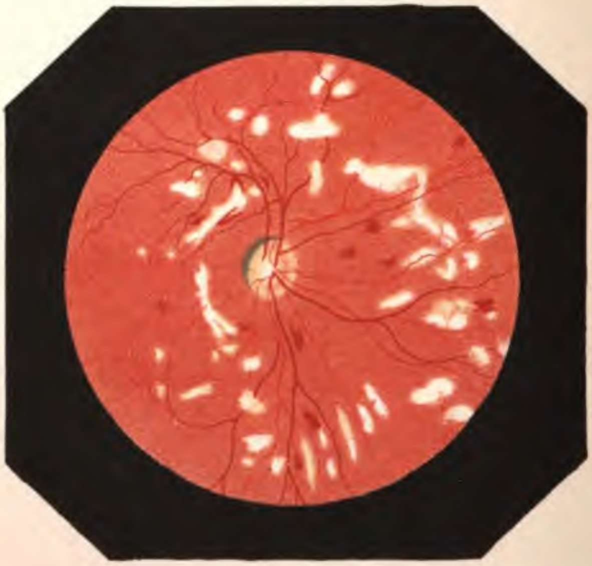

Fig. 1. Apoplectic Retinitis.
Fig. 2. Retinitis in Bright's disease.

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Retinitis

Plat

Fig. 1.

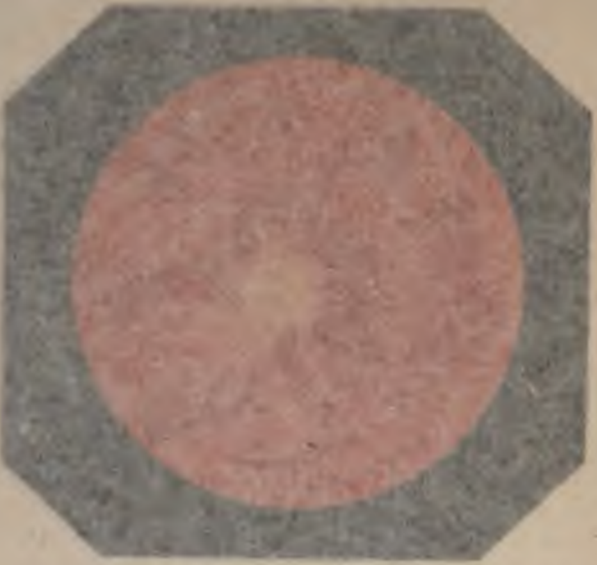

Fig. 2.

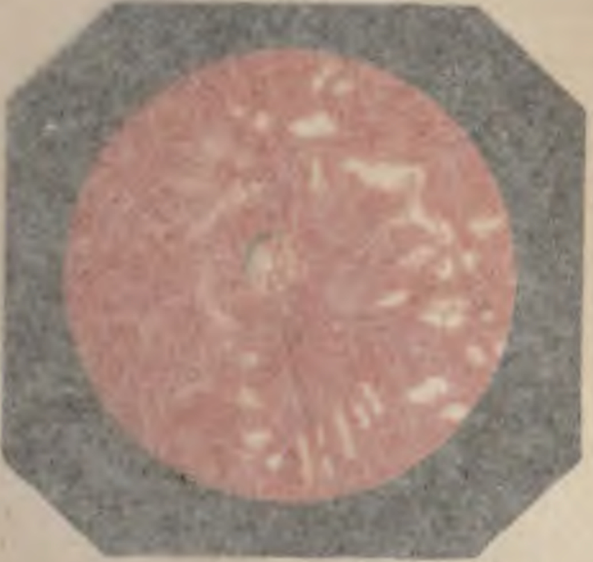

Fig. 1. Apoplectic Retinitis.

Fig. 2. Retinitis in Bright's disease.

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PLATE VII

RETINITIS

Fig. 1.—The right eye of a man with a high degree of apoplexy of the retina. Numerous retinal hæmorrhages are found scattered over the whole fundus. They are of different forms; some in the form of streaks, others round or oval spots. In the neighbourhood of the disc the blood stripes assume a fan-shaped appearance. They are numerous on the macular border of the disc. The outline of the disc is completely lost. Its colour is an uncertain yellowish red, passing gradually into the normal red of the fundus. The retinal arteries are in some places very indistinct, but the veins are more easily recognised. In some regions the extravasations lie upon and cover the retinal vessels, while in others the vessels run in front of the hæmorrhages.

Fig. 2.—Retinitis in Bright's disease. The disc is of normal appearance and colour, and at its nasal margin surrounded by a pigment border. The retinal vessels, which are distinctly separated into veins and arteries, are of normal fulness and colour, but are covered in some places by clear, white spots; these spots are irregular in shape and size, and are scattered over the whole fundus. Between them we see different hæmorrhagic spots.

Detachment of the Retina.

Plate

Fig. 1.

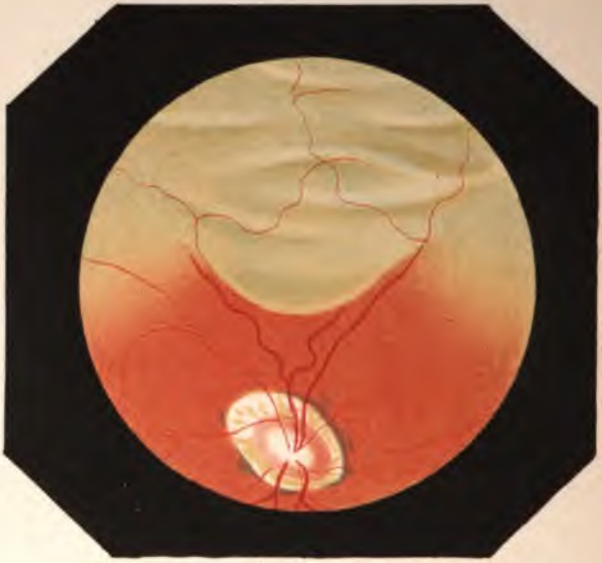

Fig. 2.

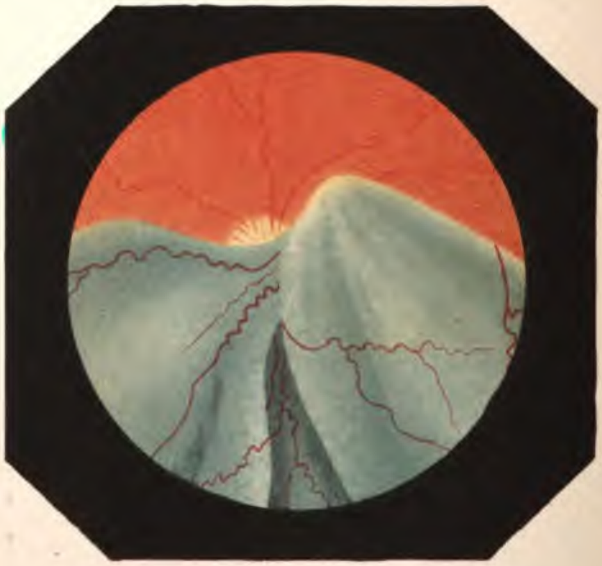

Fig. 1. Detachment of the retina with posterior Staphyloma.
Fig. 2. Detachment of the retina.

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Detachment of the Retina. Plat

Fig. 1.

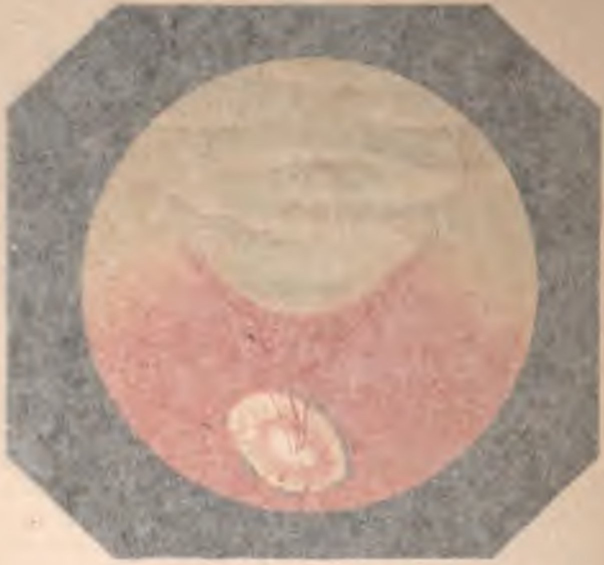
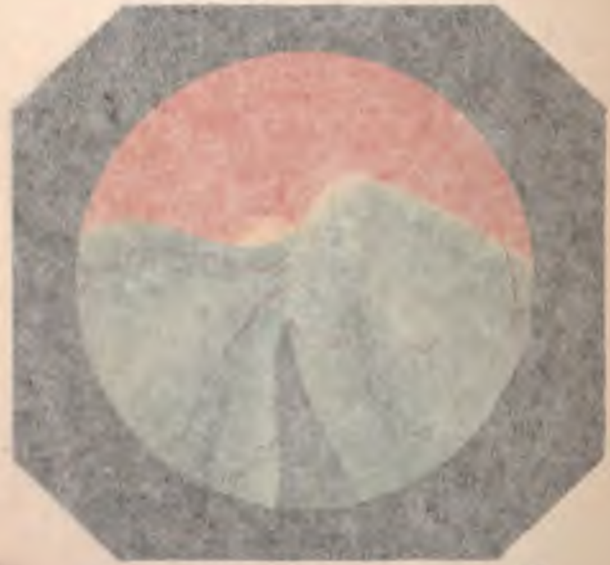


Fig. 2.



g 1. Detachment of the retina with posterior Staphyloma.

2. Detachment of the retina.

[illegible]

PLATE VIII

DETACHMENT OF THE RETINA

Fig. 1.—The upper half of the inverted image of the fundus shows a yellow-green background, with different folds running in a horizontal direction upon it. On both sides this yellowish-green part passes gradually into the normal colour of the fundus, while in the middle it rises into a bladder, bulging out towards the optic disc. The retinal vessels are more tortuous in their course upon the detachment, especially where they cross the retinal folds. The normal coloured disc is surrounded by a white concentric border, upon which is found several yellowish spots and stripes. The outer border of this posterior staphyloma is surrounded by dark pigment streaks. The retinal vessels are regular in their course, with the exception of one vein, running to the detachment, which is rather tortuous.

Fig. 2 represents an extensive retinal detachment, which is divided into two pouches by a dark-coloured ridge. The colour of the detachment is a pronounced bluish green, resembling that of sea-water. Where the light falls upon the pouch, the colour has a whitish hue. The vessels which run upon the detachment are very tortuous, like vine-twigs. Their colour is a saturated cherry brown. The rest of the fundus is of the usual red. The greater part of the disc is covered by the detachment, so that only a small border of it is visible. The retinal vessels pursue a moderately winding course upon the red fundus, but appear slightly veiled, on account of the turbidity of the vitreous humour.

Choroiditis.

Plate

Fig. 1.

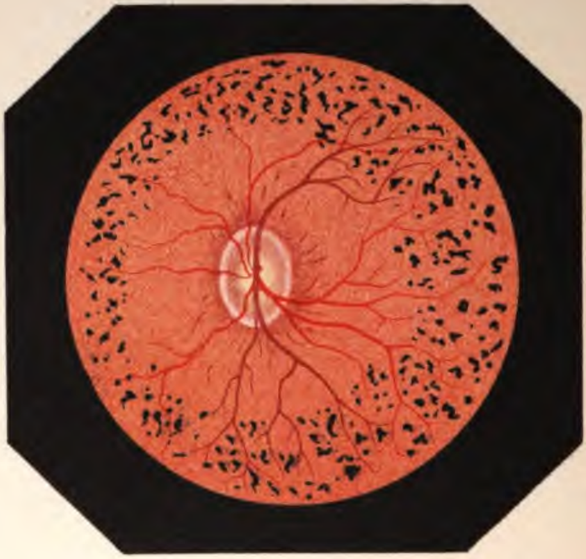


Fig. 2.

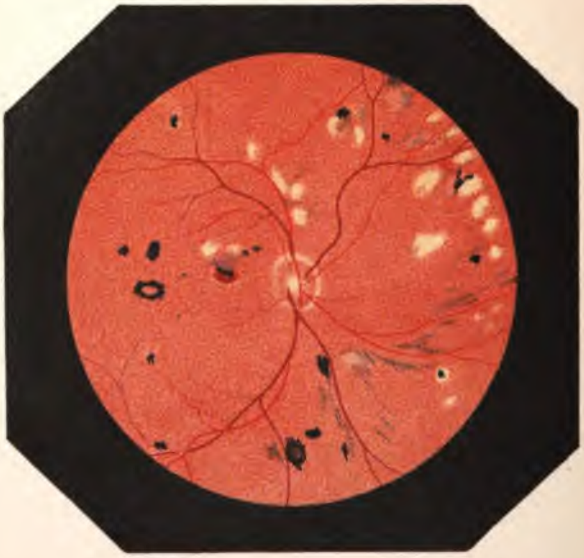


Fig. 1. Syphilitic Choroiditis.
Fig. 2. Disseminated Choroiditis.

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[illegible]

PLATE IX

CHOROIDITIS

Fig. 1.—Represents the fundus of a man, aged 35, with slight torpor of the retinæ. He is the issue of intermarriage of first cousins. The peripheric zone of the fundus, which is of a yellowish-red tinge, shows small, irregularly formed, black pigment spots. In the immediate neighbourhood of the disc the spots are entirely absent The normally coloured disc is surrounded by a narrow white border. In the retinal vessels there is nothing particular to observe.

Fig. 2.—Syphilitic choroiditis. Upon the normally coloured fundus there are scattered numerous spots of various forms and colours. Some of them are whitish, others consist of black pigment, and others, again, look like delicate, ash-grey stripes. Exactly in the region of the macula there is a fresh hæmorrhagic spot. The disc and retinal vessels are normal.

Note.—The marking of the figures at the foot of the Chromo. should be transposed.

Choroido-retinitis.

Plate

Fig. 1.

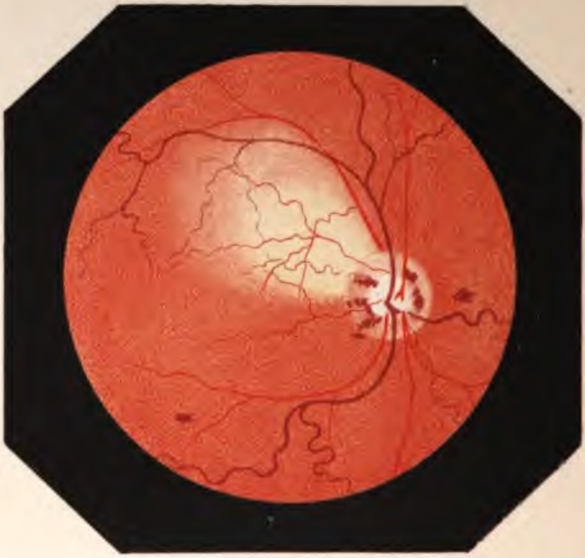

Fig. 2.

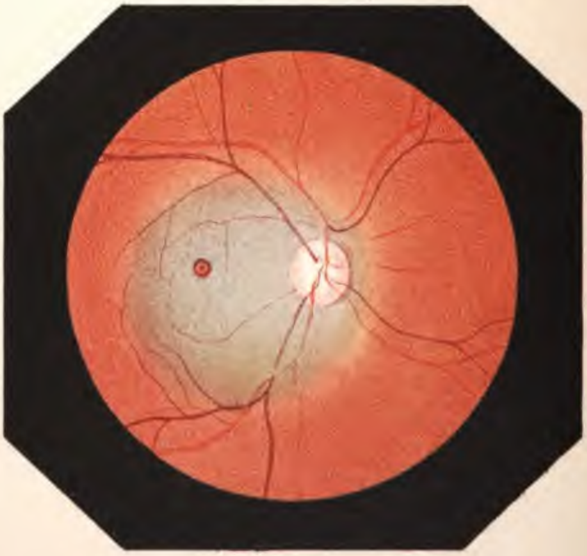

Fig. 1. Choroido-retinitis with apoplexy of the retina.
Fig. 2. Embolia Arteriae centralis retinae.

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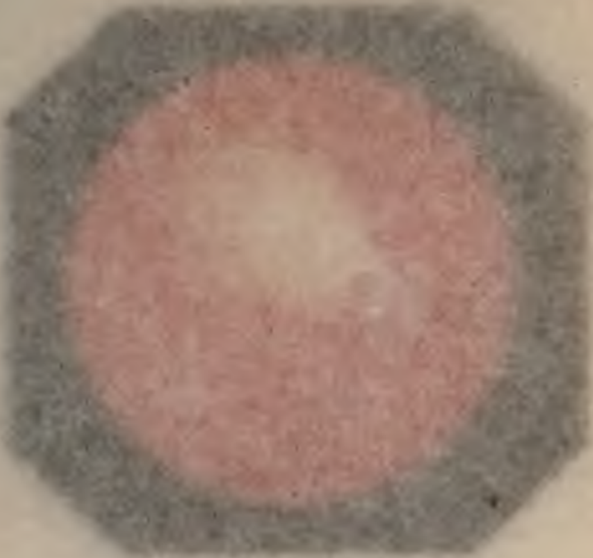
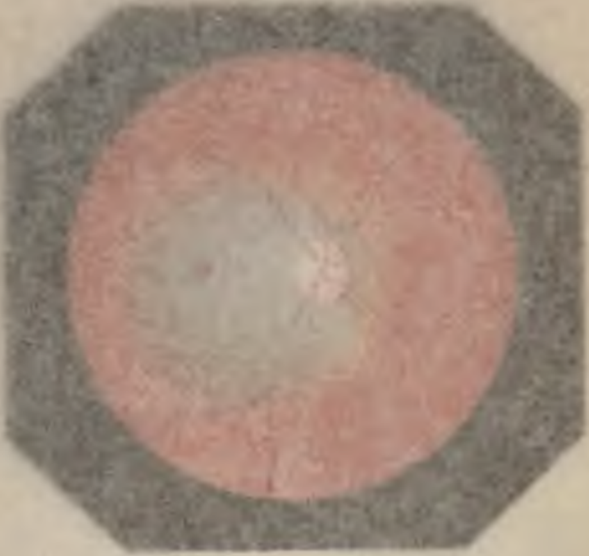
PLATE X.

[illegible]-RETINITIS

FIG. 1.—[illegible] retinitis, with apoplexy of the retina. The disc is of normal form and colour, but is covered by numerous fresh hemorrhages of a blood-red colour. Two such extravasations are also found upon the normally coloured fundus. The retinal veins show a decided tortuosity. In the inverted image, close upon the macula, there is found a very striking yellowish-white coloured part, which extends to the disc. While this spot is moderately intense in colour in the neighbourhood of the disc, towards the periphery it becomes indistinct, and changes into a grey-red colour. In the course of this gradation small retinal vessels make their appearance.

FIG. 2.—Embolia arterial centralis retinæ. The whole part situated below the macula and the disc, and partly concentric with these two organs, shows a very distinct grey colouration. The macula appears as a cherry-red spot, and its centre and periphery are particularly red brown in colour. The disc appears as if slightly veiled. The retinal vessels in the region of the grey zone cannot be distinctly recognised. They appear very thin both upon and near the disc, but assume towards the periphery their normal colours.





[illegible] Choroido-retinitis with apoplexy of the retina

[illegible] Embolia Arteriae centralis retinae.

PLATE X

CHOROIDO-RETINITIS

Fig. 1.—Choroido-retinitis, with apoplexy of the retina. The disc is of normal form and colour, but is covered by numerous fresh hæmorrhages of a cherry-red colour. Two such extravasations are also found upon the normally coloured fundus. The retinal veins show a decided tortuosity. In the inverted image, close upon the macula, there is found a very extensive yellowish-white coloured part, which extends to the disc. While this spot is moderately intense in colour in the neighbourhood of the disc, towards the periphery it becomes indistinct, and changes into a grey-red colour. In the course of this exudation small retinal vessels make their appearance.

Fig. 2.—Embolia arterial centralis retinæ. The whole part situated below the macula and the disc, and partly concentric with these two organs, shows a very distinct grey colouration. The macula appears as a cherry-red spot, and its centre and periphery are particularly red brown in colour. The disc appears as if slightly veiled. The retinal vessels in the region of the grey zone cannot be distinctly recognised. They appear very thin both upon and near the disc, but assume towards the periphery their normal colours.

ON

DISEASES AND INJURIES OF THE EYE

LECTURE I

INTRODUCTORY

GENTLEMEN,—I propose to devote this lecture to some general considerations regarding the organ of vision. The eye is the principal organ by means of which we become acquainted with the world around us. Through it there is conveyed to us an image of the size, shape, and colour of all objects which transmit or reflect light; and the medium, through which this effect is produced consists primarily of the retina and optic nerve. The retina receives the impression of light and colour, and this is conveyed to the sensorium through the fibres of the optic nerve.

These structures form the organ of vision in its most rudimentary condition as met with in some of the lower forms of animal life, as in the *Echinodermata*, where nothing is found but a nervous cord and a pigment spot. Rays of light coming in contact with the pigment spot impart some molecular motion, and luminary or calorific impressions are produced. Ascending in the zoological scale we have the visual organ in a degree of perfection and development commensurate with the requirements of the animal. In the *Tubelaria*, for instance, which range in search of their food, there are, as in the leech, numerous eye spots scattered about the head, and by these their movements are guided. Similar eye spots may be seen in the *Rotifera*, in which the rudiments of a proper optical instrument begin to show themselves, although they are sometimes buried beneath the integuments.

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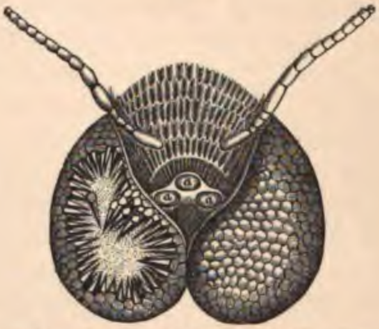
The *Pecten* and several other *Conchifera* have their eyes placed along the margin of their mantles, while the *Medusæ* have theirs at the end of their bell-shaped bodies, and the *Sabellæ* upon their gills. In two of the highest orders of the *Crustaceæ*, the *Podophthalmata*, for instance, the eyes are placed at the extremities of their movable peduncles, as the name implies. The advantage of this is obvious, for the head and thorax being consolidated into one mass the extent of vision commanded by sessile eyes would have been inadequate for the security of creatures exposed to so many enemies. In some of the *Dorsibrachiata* they are found in the extremity of the tail, whose movements they direct.

In *articulated* animals the eyes are composite; thus the *bee* has two large eyes, one on each side of the head, consisting of numerous facets—primary eyes, and three shining spots above—secondary eyes. Every one of the facets is in itself a complete visual instrument, as seen in

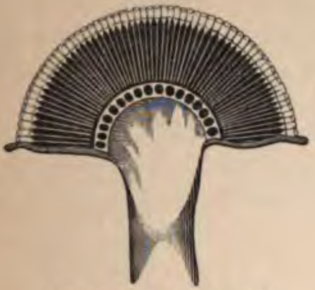
FIG. 1.



Head and compound eyes of the bee, showing the ocelli or primary eyes *in sitû* on the left side, and displaced on the right; (*a a a*) stemmata, or secondary eyes.

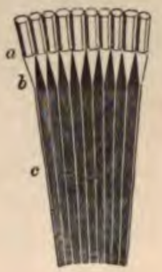
When a vertical section is made of one of these composite eyes it is seen that each ocellus is the frustrum of a pyramid, of which the cornea forms the base (Figs. 2 and 3), whilst the small end abuts upon a bulbous expansion of the optic nerve; the interior of this pyramid is occupied by a transparent substance (*b*), which represents the vitreous humour, and the pyramids are separated from each other by a layer of dark pigment, which completely encloses them, save at the papillary apertures, and also at a corresponding set of apertures at their

FIG. 2.



Section of the eye of cockchafer.

FIG. 3.



A portion more highly magnified.

a, facets of the cornea; *b*, transparent pyramids surrounded with pigment; *c*, fibres of the optic nerve; *o*, trunk of the optic nerve.

smaller ends, where the pigment is perforated by the fibres of the optic nerve (*c*).[1]

In the *Arachnidæ* we find a reduction in the number of eyes. Some spiders have only two, and none more than eight. The scorpion has two large eyes placed on the dorsal aspect of the cephalothorax, and three pairs of smaller eyes on the outer margin of the same division of the body.

We may therefore assume that the number and position of the eyes in animals are in intimate correlation with their life-condition, their place of abode, and the work they have to perform. This is the case even in the vertebrata, where the eyes are of the same type throughout; for example, the eyes of fishes are remarkable for the spherical shape and density of the crystalline lens, which enable them to exert its refractive power upon rays which come through water. We have another example in the development of the muscle of accommodation in birds of prey, to whom distinct vision is necessary at widely different focal distances; but it is nowhere more strikingly manifested than in the fact that the larvæ of insects, which undergo a complete metamorphosis, only possess simple eyes, the composite eyes being developed at the same time as the wings and other parts, which are characteristic of the imago state during the latter part of the pupa condition. On the other hand, we find in the metamorphosis of the Schmarotzer crabs and cirripedians that, in passing from their larval condition, they lose at the same time the eyes by means of which they were formerly able to exercise free control of motion. Spiders living underground have no eyes at all.

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[1] Carpenter's 'Principles of Comparative Physiology,' p. 727.

See also J. Müller, 'Zur vergleichenden Physiologie des Gesichtssinnes des Menschen und der Thiere,' Leipzig, 1826; and

Leuckart, 'Organologied es Auges; in Graefe and Saemisches' Handbuch der Augenheilkunde.'

THE HUMAN EYE

Is the most perfectly developed of all those found in the vertebrata. Let us consider it in the first instance as an optical instrument, such as a photographic apparatus, which it resembles in its mechanism. The parts used for the construction of such an apparatus are:—A plate of glass, rendered sensitive to the rays of light by being covered with Argenti Nitras and gelatine, to receive the impressions of the image; a convex lens to render the image distinct; a dark chamber (camera obscura) and diaphragm, to prevent reflection and aberration of the rays; and an adjusting mechanism to regulate the distance between the plate and the lens, so as to adapt it for different focal distances.

The corresponding parts in the human eye are:—

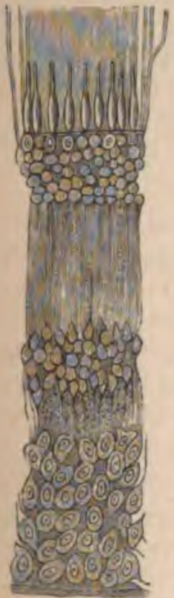
1. Retina to receive the impression of the image.
2. Compound lens for refraction, *i.e.* to bend the rays coming from objects, so as to bring them to a focus upon the retina.
3. Sclera and choroid forming the dark chamber.
4. Iris, the diaphragm to correct spherical aberration.
5. Ciliary muscle, serving as an adjusting mechanism to adapt vision to different focal distances.

The *retina* (network) is the nervous membrane of the eye situated between the choroid coat and the hyaloid membrane of the vitreous humour. It commences at and surrounds the terminal part of the optic nerve, and extends forwards nearly to the anterior edge of the ciliary processes, where it terminates in a finely serrated border (ora serrata).

The following layers may, according to Kölliker, be observed in the retina :—

They are represented in their order from without inwards.

Fig. 4.



The rod and cone layer rests upon the choroid and the *membrana limitans interna* rests upon the hyaloid (limitans hyaloidea).[1]

All the parts of the retina are not equally impressible by light. The most acute perception resides in the region of the *macula lutea*, yellow spot, which is therefore the most important part, but is found only in men and monkeys. In the centre of the macula there is a depression—fovea centralis; and it is here that direct acute vision takes place, as was first demonstrated by Heinrich Müller in 1847. He also proved that the rod and cone layer was the impressible membrane, since in the region of the macula, and especially in the fovea centralis, the retina is represented principally by the cones. These cones are present here in perfection, along with nerve-cells and a nuclear layer, all the other layers being pushed aside, as it were. Vision of the fovea centralis is called acute or direct, *i.e.* the image is painted upon it, while that of the other parts of the retina is called indirect or *peripheric.*

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[1] The term "limitans hyaloidea" was first used by Henle, who denies the existence of two membranes between the vitreous and the retina, and describes only one. Some anatomists regard this membrane as an integral part of the retina (Ivanoff, in 'Graefe's Archiv,' Bd. xi, pl. i, fig. 141), and others as an independent structureless membrane with one epithelial layer (Hannover, 'La rétine de l'homme et des vertébres,' p. 130).

All the theories propounded with regard to the manner in which light acts upon the retina barely approached the limit of probability, until the recent publication by Franz Boll of his observations on the photo-chemical action of the retina.[1]

Experiment.—If a frog be taken and kept in darkness for some time, then decapitated, and the head left in a dark place for twenty-four hours, on removing the eyeball and opening it, the retina will be found of a beautiful red colour. Expose this to some light and the red gradually disappears, the membrane gets pale, then yellowish, then like white satin, while ultimately even this appearance vanishes and the retina becomes quite transparent.

The red principle of the retina, which is generated in darkness and decomposed in sunlight, Boll calls *erythropsine.* The fact that it exists after the death of the animal shows that it is not a transitory property, but a durable chemical element of the retina, analogous to the hæmoglobine of the stroma of the red corpuscles of the blood. The *erythropsine* is transformed by the light into several physiological combinations, just as the hæmoglobine is changed by the action of different gases, the chemical combinations resulting from the action of light upon the erythropsine; in other words, this process constitutes the essence of perception of light and colour.

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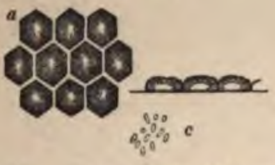
[1] Memoir read before the Academia dei Lincei, Rome, 'Annales d'Oculistique,' June, 1877.

There is another factor in this physiological process which we must notice. Behind the retina there is a layer of epithelium of the choroid with hexagonal pigment cells. These cells contain oil-globules, which Boll considers to be the primary materials from which the *erythropsine* is incessantly reproduced. These peculiarly shaped pigment cells behave very curiously. They seem to be migratory cells. When the eyes have been kept in darkness or in a red or yellow light, the retina can be easily separated from the pigment layer as a distinct membrane; but, when the eyes are exposed to white, green, blue, or violet light, the pigment extends into the interstices of the retina and the rod and cone layer cannot be separated from it.

FIG. 5.

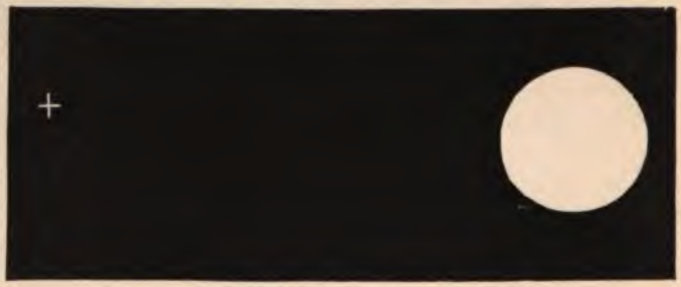


Hexagonal pigment-cells: *a*, seen from the surface; *b*, from the side; *c*, pigment granules.

The experiments made by Boll upon frogs, and also upon cartilaginous and osseous fishes, have been repeated upon the human eye, after a capital execution with the same result by Schenke and Zuckerkandel of Vienna. *A propos* of the photo-chemical theory, it appears to me to bring us one step nearer to a comprehension of the intimacy which exists between mental operations and physical action, for it shows us that the image of objects is actually impressed upon the retina. May I not add that the mind stores up these impressions, that memory is the faculty by which these plates are brought forth when required, and that thus the analogy between the retina and the photographic plate is strictly correct, the main difference being that the retina gives us a chromo-photograph.

The retina, then, is the membrane which receives the impression of the image, and this is conveyed to the brain by the optic nerve. The optic nerve is merely the conductor, but is itself insensible to light, as was demonstrated by Mariotte in 1668.

Fig. 6.



If you shut your left eye and look with the right upon the white cross (Fig. 6), you will find when you remove the figure about twelve inches from the eye that the white circle disappears and you see only a continuation of the black. Place any coloured object upon this circle, and it will equally be invisible if you only look fixedly at the white cross. There is, therefore, at the *outside* of the fixation point or macula a blank in the field of vision; and when you consider that the natural images are inverted, you will see that the blank corresponds to the part of the retina situated at the *inside* of the macula. We can indeed determine by measurement that it corresponds to the point of the entrance of the optic nerve, which is called the blind spot or Mariotte's spot.

Refractive Media

Rays of light proceeding from any object would form a diffused image upon the retina unless there were some means of bending them and bringing them to a point—focus—upon it, and this is effected in the eye by structures which serve the purpose of a convex lens.

The refractive media of the eye are:—Cornea, aqueous humour, lens, with its capsule and vitreous humour. The cornea is a membrane consisting of parallel surfaces, and, like a window-pane or a watch-glass, cannot give a new direction to a ray of light which traverses it; the action of the cornea may therefore be disregarded. There remains thus the aqueous humour, the lens, and the vitreous humour; these have different powers of refraction (refractive indices). Indeed, the crystalline lens itself is not a simple refractive medium, its consistence and index of refraction increasing from the anterior layer to the centre or nucleus. These media, with their different refracting surfaces (viz. the anterior surface of the cornea, the anterior surface of the lens, the posterior surface of the lens), arranged and placed at certain distances from one another, constitute the compound lens or object glass of the eye for projecting the image upon the retina.

The dark chamber for absorbing the rays of light which enter the eye and for preventing their reflection after they have acted upon the retina, is formed by the sclerotic with its pigmentous lining—the choroid, and the dark lining of the iris—uvea.

The *choroid* or the vascular tunic of the eye is a dark-brown membrane lying between the sclerotic and the retina. It consists chiefly of blood-vessels, among which, however, pigment is abundantly interspersed in nucleated cells, with processes frequently branching at irregular intervals. A peculiar fibrous tissue is added, which holds all in place and confers some little toughness upon the membrane. The optic nerve passes through it as well as the sclerotic at its posterior portion by the round *foramen opticum choroidea*, and is supported there by an elastic connective-tissue structure, which forms an actual ring, the so-called fibrous ring, which is intimately connected with the neurilemma of the optic nerve. At this ring the choroid slightly adheres to the sclerotic, but in the rest of its extent it is hardly, if at all, united to the external tunic. Anteriorly the choroid has an imaginary boundary line at the *ora serrata*, where it is also firmly united to the retina. The uveal tissue is continued over this boundary and forms the projections known as the ciliary prolongations or processes, whose aggregate is described as the ciliary body.

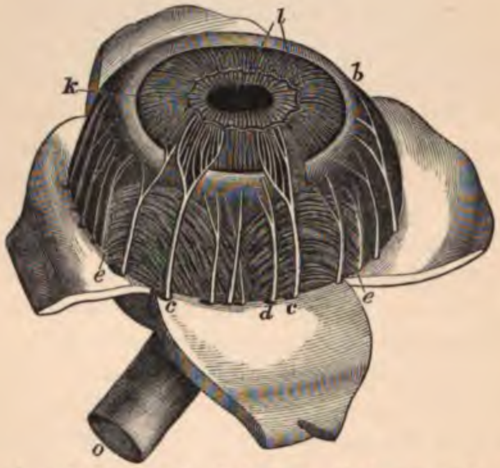
We distinguish a number of layers in the choroid, viz.:—

1. External pigment layer or lamina fusca.
2. Vascular layer or tunica vasculosa.
3. Membrana chorio-capillaris or Ruyschiana.

4. Lamina elastica or membrana limitans.
5. Stratum pigmenti.

On removing the sclera there is brought into view the *lamina fusca*, which is a coarse filamentous tissue from brown to black in colour, which envelopes the long ciliary vessels and nerves which pierce the sclera a little in front of the optic nerve and divide into branches till they enter the ciliary muscle.

FIG. 7.[1]



Flap of sclerotic reflected; brings into view *c c d*, ciliary nerves proceeding to the iris and ciliary muscles; *e e*, vasa vorticosa; *b*, ciliary muscle forming a grey ring round the periphery of the iris; *k*, radiating fibres of the iris; *l*, circular fibres, or sphincter iridis.

The *vascular* layer, which is always less highly coloured, and the colourless *chorio-capillaris* represent the real structure of the choroid. When the choroid has been so fully injected through the ciliary arteries that the fluid has completely traversed the capillaries and veins, we see its outer surface to be composed of arterial and venous branches, and its inner surface of capillaries. The arteries, comparatively small, take a meandering course forwards between the veins, while the veins run in curves (vasa vorticosa) to four or five principal trunks by which the blood leaves the organ. The capillaries form on the inner surface of the choroid a plexus with close meshes, known as the Tunica Ruyschiana, and this network is closer, *i.e.* the meshes are smaller in the hinder part than in front, and the vessels are finer. Mr Bowman has pointed out that it is the most important part of the choroid, because the capillaries are a more important structure than either the arteries or veins in regard to the function of the membrane, and also with regard to disease. In no part of the body are the arteries and veins so separated by a natural disposition from their own capillaries; and it is most interesting to notice, in accordance with this circumstance, that when the choroid is so inflamed that inflammatory products result, they are poured out from its inner rather than from its outer surface.[1]

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[1] Berl. 'Encyclop. Anatomy.'

The *lamina elastica*, or membrana limitans of the choroid, is a delicate, perfectly structureless membrane, covered by isolated very bright nuclei. It appears to be analogous in its structnre to the hyaloid membrane, and extends over the whole of the inner surface of the chorio-capillaris, to which it is closely connected, although it may be separated from it in large pieces, especially in the macerated choroid.

The *pigment stratum* is on the inner surface, and consists of the regular hexagonal cells, mentioned above, lying close together next to the retina.

The *ciliary body* is a continuation of the choroid, and it may be considered as its ciliary portion. The processes are embedded in the depressions of the zonula of Zinn, and fill them up to within a short distance of the border of the lens. These processes are folds in whose anterior concavity the ciliary muscle rests, and their structure is analogous to that of the choroid, with the exception of the chorio-capillaris, which ends at the ora serrata.

THE IRIS,

Which serves the purpose of a diaphragm, is a circular membrane, placed in the anterior part of the eye, before the crysline lens. It divides the aqueous humour into an anterior and posterior chamber, and has an aperture—pupil—which is nearly circular, and is placed a little to the inner side of the centre. The anterior surface, variously coloured in different eyes, is covered by the same epithelium as that which lines the internal surface of the cornea (Descemet's membrane). It presents radiating fibres, which converge towards the pupil, and which form two distinct zones, the external and larger being generally of a brighter colour than the pupilary or smaller ring (Fig. 7, *l*). Its posterior surface, turned towards the crystalline lens, is covered with dark pigment—the uvea, and if this be removed there is seen, at the margin of the pupil, a narrow circular band of fibres, the sphincter muscle of the iris. Fibrinous and muscular tissues form the groundwork of the iris. The muscular fibre is of a non-striated kind, and is disposed in a ring round the pupil and as rays passing from the outer margin of this ring to the circumference.

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[1] 'Lectures on the parts concerned in the Operations on the Eye,' 1849.

We may, therefore, describe the iris as consisting of two distinct muscles, namely, sphincter and dilator, which are antagonistic to each other in their action.

The blood-vessels of the iris are derived from two sources: the *long ciliary* arteries pierce the sclera in the neighbourhood of the optic nerve, and pass along its inner surface to the ciliary muscle, where their branches form an anastomosing circle, sending off shoots towards the pupil, round which a second circle is formed; the *anterior ciliary* arteries, on the other hand, pierce the sclerotic near its junction with the cornea, and go to form part of the vascular circle in the ciliary muscle. The distribution of the veins corresponds with that of the arteries.

The *nerves* which supply the iris are:

1. Motor oculi. 2. Trigeminus. 3. Sympathetic.

These anastomose with the Gasserian and ophthalmic ganglia. The motor oculi furnishes the ophthalmic ganglion with its short root, which goes to supply the sphincter iridis, whilst the cephalic filaments of the sympathetic supply the dilator iridis.[1]

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[1] The experiments of Valentine tended to prove that the pneumogastric nerve participates with the sympathetic in causing dilatation of the pupil; but in operating upon animals it is difficult to isolate the pneumogastric from the sympathetic, and hence the direct action of

The trigeminus supplies the iris and the eyeball with general sensibility, and its ganglionic root imparts to it tactile sensibility. This is established by the following experiments:—When we expose the motor oculi and irritate it mechanically the pupil contracts; when we cut it or apply atropine to the eyeball the pupil dilates by the action of the antagonistic nerve—the sympathetic. On the other hand, when we irritate the sympathetic, the pupil dilates, but if we cut it, or apply extract of Calabar bean to the eyeball, the pupil contracts by the action of the motor oculi.[1]

The iris, then, acting as a diaphragm, allows the rays of light to enter only through the central opening—the pupil, and such an arrangement is necessary for the formation of a distinct image; for rays of light passing through a convex lens whose curvature is circular are not all brought to a focus at the same point, those which pass through the margin of the lens being made to converge into one focus, while those which traverse the central portion collect in a different focus, and mar the distinctness of the image; hence the necessity for the correction of *aberration of sphericity* by some means which will cut off the marginal rays and allow a distinct image to be formed at a point called the geometrical focus, where the rays are thickest.

I may mention here another defect in ordinary convex lenses, namely, *chromatic aberration*. It is owing to the unequal degree in which coloured rays are refracted, so that they are brought to a focus at different points. The violet rays being most refrangible are soonest brought to a focus, and the red being the least refrangible have their focus at the greatest distance from the lens; hence it is impossible to obtain an image by an ordinary lens, in which the colours of the objects are accurately represented, for the foci of its differently coloured portions will be different, and its white rays will be decomposed, so that the white centre will be surrounded by coloured fringes.

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the former upon the iris is not sufficiently proved. But it is probable that it may have an indirect influence upon the movement of the iris through the respiratory and circulatory organs.

[1] Claude Bernard, 'Leçons sur la Physiologie et la Pathologie du Système Nerveux,' 1857.

The optician is able to correct the defects of these aberrations by combining lenses of different densities, and thus we find that in all optical instruments the object glasses consist of flint and crown glass cemented together, with their curvatures so arranged as to cover each other's defects without neutralising the refractive power. It was generally supposed that the eye, having its refracting apparatus composed of media of different densities, with refracting surfaces of different curvatures, was a perfect optical instrument, free from spherical or chromatic aberration; but this is not the case. The eye is not free from those defects, in the strictest sense of the term, and its want of symmetry, its astigmatism, its blind spots, and its lack of achromatism, caused Helmholtz to say that if any optician sent him an instrument so full of defects he would be justified in sending it back with the severest censure. When, however, we consider that the eye is a self-adjusting apparatus, we must agree with Tyndall in saying that it must not be judged from a theoretical standpoint, but as a practical instrument, and that, taking the adjustment by which its defects are neutralised into account, it must ever remain a marvel to the reflecting mind.[1]

The course followed by rays of light on entering the eye is through the cornea, the aqueous humour, the lens with its capsule, and the vitreous humour. These may be regarded as a compound object glass, which make parallel or slightly divergent rays converge to a focus, and if the retina is at a proper distance a small inverted image of an object is formed upon the retina.

The fact of the inversion of the image has been disputed by some writers, and I have seen a French work with diagrams to demonstrate that the retinal images are not inverted. But all reasoning on the subject is superfluous when we can demonstrate the fact. Let a fresh bull's-eye, with transparent cornea, be taken and the posterior hemisphere of the sclerotic and choroid be removed to the insertion of the optic nerve; on holding it with the cornea directed to the window you will see that the images are painted upon the retina in an inverted position, and Fig. 8 will show you how that inversion takes place. You will see that this inversion is a necessary consequence of the intersection of the rays; for, as light proceeds in straight lines, those rays which come from the lower part of an object, on crossing those which come from its upper part, will represent this part of the object on the upper half of the retina, and for the same reason the upper part of the object will be painted on the lower part of the retina. But then, it may be asked, how do we see things erect when the retinal images are inverted? The explanation is that the small retinal image is a mere nervous impression of which the mind takes cognisance, and which it exteriorates, *i.e.* refers to a certain place, measures its distance, size, and shape, and inverts it. This is the work of the mind, which by a process of education, aided by the sense of touch, it is enabled to effect intuitively.

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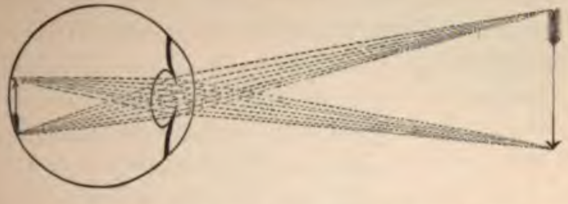
[1] 'Lectures on Light.'

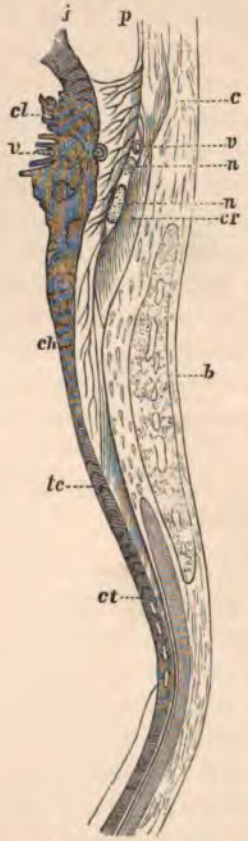
FIG. 8.



THE ADJUSTING APPARATUS

Is represented in the eye by the ciliary muscle, which serves to accommodate its optical mechanism to different focal distances. This muscle, like the iris, consists of two sets of fibres, circular and radiating, which are antagonistic in their action to each other. The radiating fibres, which are attached anteriorly to the pillars of the iris and posteriorly to the choroid, form a greyish semi transparent band, about one eighth of an inch broad, on the anterior surface of the choroid (Fig. 7, *b*). This band is thickest at its anterior edge, and becomes gradually thinner backwards, terminating nearly on a line with the *ora serrata*, and corresponding, therefore, on its inner surface to that striated and plicated part of the choroid in front of the retina where the choroid takes hold of the vitreous body. The circular portion—the *punctum mobile*, extends inwards towards the optic axis as far as the tips of the ciliary processes. For the sake of analogy to the iris, we may as well call them, with Max v. Langenbeck, two muscles—circular and radiating; for indeed, in the largest birds of prey these two muscles are quite distinct, and are separated by a considerable interval, as represented in[1]

FIG. 9.



Longitudinal section of ciliary region of eagle's eye. *c*, cornea; *p*, pillars of iris; *cl*, ciliary processes; *v*, section of blood-vessels; *n*, section of ciliary nerves; *cr*, Crampton's muscle; *ch*, choroid; *b*, bony plate; *tc*, tensor muscle of the choroid; *ct*, cartilage.

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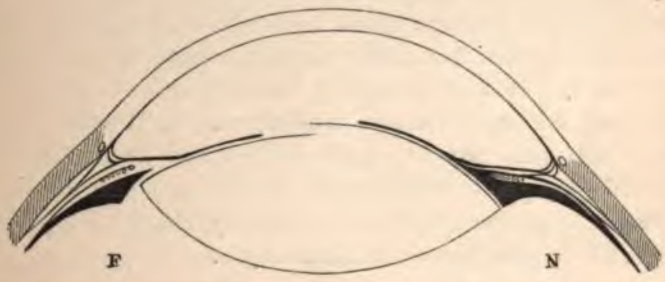
[1] From "Hulke's Lectures on the Histology of the Eye," 'British Med. Journal,' September, 1870.

The foremost muscle was described by Sir Philip Crampton and bears his name.

In the human eye, the circular muscle—*musculus compressor lentis accommodatorius* (of Langenbeck) or sphincter capsulæ (of Müller) compresses the rim of the lens, rendering its anterior surface more convex, and thereby lengthening its axis, which accommodates the eye for near vision.[1] The radiating muscle withdraws the ciliary processes from the circumference of the lens, causes the lens to return to its condition of a state of rest, and thus accommodates the organ to distant vision.

FIG. 10[2]



N, accommodation for near objects producing shortening of the circular muscle and lengthening of the radiating; lens more convex. F, accommodation for the far point, shortening of the radiating, and lengthening of the circular muscle; lens becoming flatter.

According to this view of the subject, the term *tensor choroidea*, used by Müller to designate the fixed part of the ciliary muscle is inapplicable to it, for instead of its pulling the choroid forward, its action, on the contrary, is to put the choroid in a state of relaxation.

The nervous supply is the same as in the iris, the circular muscle being dominated by the third nerve and the radiating muscle by the sympathetic. Fig. 10 shows the action of the iris and ciliary muscle and the state of the lens in viewing distant objects, and also their condition in accommodation for near objects. You will notice that the lens becomes more convex in accommodation for the near point, or, in other words, a meniscus is added to it.

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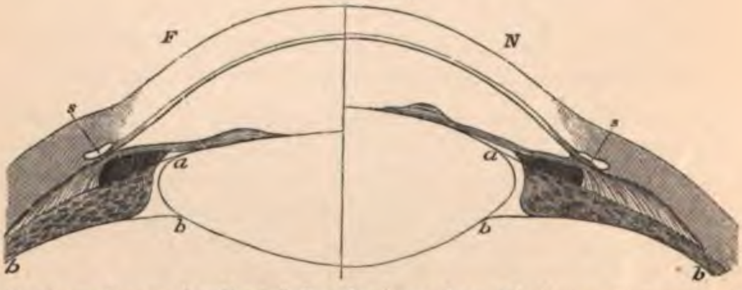
[1] You may bring the *compressor lentis* into view by removing a segment of the radiating fibres of the iris (*k*, Fig. 7), when you will see it proceeding from the grey round muscle (*b*) towards the ciliary processes. You will also see the ciliary processes grasping the periphery of the lens like tags which secure the jewel in a ring.

[2] Henke, 'Archiv f. Ophthalmologie,' 1860.

The mechanism of accommodation, however, is still a disputed point in physiology, and several theories are current on the subject. According to Helmholtz,[1] whose views are most generally adopted, the eye undergoes the following changes during accommodation :—*a*. The pupil contracts in accommodation for the near point; it dilates for distant vision. *b*. The pupillary margin of the iris and the centre of the anterior surface of the lens move forward in accommodation for near objects; simultaneously the peripheral part of the iris sinks back. This is necessarily the case, since the volume of the aqueous humour remains unchanged. *c*. The anterior surface of the lens becomes more arched, and its vertex moves forward; the posterior surface of the lens also becomes slightly more arched, and does not perceptibly change its position. Fig. 11 illustrates those various changes.

FIG. 11.



F, when the eye is adjusted for the far point; *N*, when accommodated for the near point. *a a*, the zonula; *b b*, the hyaloid membrane.

When the eye is in a state of rest, the iris forms a curve in the vicinity of *s* (Schlemm's canal), but when accommodated for the near point the iris is contracted, the periphery becomes straightened, the anterior chamber lengthened, and the anterior surface of the lens advances forwards.

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[1] 'Optic Physiologique,' pp. 142—169.

Schweigger and others again maintain that "the phenomenon of accommodation is reduced to an antagonism between the elastic strength of the lens on the one side, and the zonula on the other, which is excited by the action of the ciliary muscle. The lens, from its elasticity, has a tendency to approach a spherical shape; the zonula tends, by reason of its elasticity, to flatten the lens. So soon as the zonula is relaxed the lens will follow its own elastic tendency, and will assume a greater convexity. It may, with the greatest probability, be assumed that both the radiating and circular fibres of the ciliary muscle act simultaneously to relax the zonula; the elasticity of the lens then comes into play. Upon the cessation of muscular contraction the elastic tension of the zonula acquires the ascendancy, and then occurs that flattening of the lens which corresponds to the condition of relaxed accommodation."[1]

I have, however, adopted Langenbeck's theory, as, in my opinion, more intelligible and satisfactory than any other.

The ciliary muscle may be regarded as taking the active part in accommodation, the lens being merely passive, while the iris assists in cutting off circumferential rays. The pupil contracts in accommodation for near objects and dilates for distant vision. Accommodation takes place even after the iris is entirely removed, but in such a case the image is blurred by a circle of diffusion.

Zonula of Zinn

We may notice in relation to these parts another membrane which undergoes some change during the process of accommodation, viz. the zonula of Zinn or suspensory ligament of the lens. This is a firm transparent membrane, attached to the fore part of the lens-capsule, close to its circumference, and passes outwards to join the hyaloid membrane at its anterior part opposite the ora serrata. It is covered by the ciliary processes, and when these and their pigment are removed by washing, small but regular folds come into view near the lens. These are plaits in the membrane, and are received into the intervals between the ciliary processes, into which they fit. When the eye is at rest, *i.e.* its accommodation relaxed, the zonula is on the stretch; and when the eye is adjusted for near vision, the zonula is thrown into folds. The zonula is connected with one layer of the hyaloid, whilst another layer of the hyaloid goes to the posterior surface of the lens-capsule. The interval between the zonula and this layer is described as a triangular space surrounding the edge of the lens, called the canal of Petit, for on removing the tunics of the eye you may blow air into the space through an opening in its anterior boundary, and this causes the plaits of the suspensory ligament in front to distend and the canal presents a sacculated appearance. I am, however, inclined to adopt the view of Henke,[1] that the dilatation in question is an artificial production, and that in the normal condition of the parts there is only a slit between the two membranes, as in the cases of the pleura, the peritoneum, or the synovial membrane of joints.

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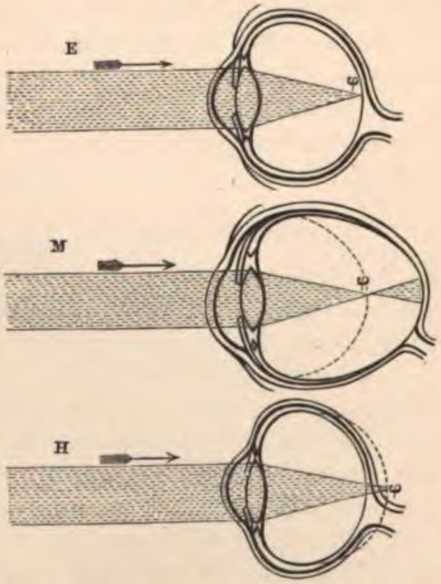
[1] 'Handbuch der Ophthalmologie,' 4th ed., 1880.

FIG. 12.



I have thus given you an outline of the component parts of the eye considered as an optical instrument, and it may be here mentioned that when regularly formed and of normal refraction the eye is said to be emmetropic (ἔμμετρος, keeping the exact measure, ὤψ eye), the retina being situated at the proper distance from the refractive apparatus, namely, at its principal focus, so that when accommodation is relaxed, parallel incident rays unite on the layers of rods and cones, forming an image upon it. When the focus is in front of the retina the eye is said to be myopic or near-sighted, and when the focus is behind the retina the eye is said to be hypermetropic (ὑπερ μετρον ὤψ).

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[1] 'Archiv f. O.,' above referred to.

In Fig. 12 E represents an emmetropic eye, in which the retina is situated exactly at the principal focus of the dioptric system; M, a myopic eye with a long axis, and the focus in consequence in front of the retina; H, a hypermetropic eye with a short axis, and the focus in consequence behind the retina.

When there is an irregularity of the curvature of the dioptric surfaces of the eye, which deviate in various degrees from the normal spherical form, the eye is said to be astigmatic (from ἀ and στιγμα, a point), and signifies that rays proceeding from a common point do not again converge to one point.

We shall return to this subject in our treatment of the anomalies of refraction.

LECTURE II

THE METHODS OF EXAMINING THE EYE

Gentlemen,—You should accustom yourselves, in examining the various forms of eye diseases or visual disturbance, to interrogate the tissues themselves, exploring the deep structures, and examining the optical mechanism, and thus find out the nature of the derangement, independently of the statements of the patient. You will find in the large majority of cases, indeed, that the subjective symptoms rather tend to confuse than to throw light upon the matter, and in many cases you must form an opinion contrary to the views of the patient. Accustom yourselves, then, to examine the patient at a distance, for in some diseases you can properly examine only in this manner. For instance, some forms of strabismus disappear when the patient comes near you, and there are other diseases which you can judge best by the manner in which the patients carry their heads, and from the way in which they approach you. A patient with cataract keeps his head bent, knits his brow, and shades his eyes with his hand, as if endeavouring to keep his eyes in the shade, the effect of which is to dilate the pupil, and admit the rays of light through the periphery of the lens. When approaching you he drags his feet cautiously upon the ground, as a person would do in a dark unknown room. In short, either by design or instinct, he avoids the light, and puts his eyes in the shade. He is very awkward and timid in his movements, and very apt to stumble against obstacles. On the other hand, in diseases of the retina or optic nerve, commonly called amaurosis, you see the patient walking erect, the head inclined backwards, and the eyes directed upwards, as if he were anxious to catch the last glimpse of light. He generally walks with firm steps, without timidity, and the whole sole of his foot is planted at once upon the ground. You can make your diagnosis in such cases before the patient comes near you, and have only to confirm your opinion by further examination, when you will see that, in the case of the cataractous patient, the lens is opaque and the pupil active, while in the other case the media are transparent, while the pupil is rigid and, it may be, widely dilated.

If you see a patient twisting his head to one side when he is approaching you, and there is no external inflammation, you should ask him whether he sees double, as paralysis of some of the muscles which move the eyeball is very likely present; for a patient thus affected twists his head to the unaffected side, in order to obviate the disagreeableness of double vision. When a patient twists his head to one side and downwards, and comes toward you with uncertain steps, hesitating in his movements, you will judge that it is paralysis of the fourth nerve, in which affection there is vertigo in trying to look downwards; or you may diagnose by his gait the presence of "locomotor ataxia," in which case you will notice, on examining the condition of the pupil, that its sensibility to light is abolished, that when we engage the patient in conversation with his eye directed to the window, and pass the hand before his eye, or shade it with the eyelid, the pupil is stationary, whilst if we make him look at a near object the pupil contracts, showing the contractility of the pupil in the voluntary act of accommodation.

In the nearer examination learn to take in at a glance the whole condition of the parts—eyelashes, conjunctiva, caruncula, cornea, &c. See if the lashes have a singed appearance, put them under the microscope along with some crusts of the border, and you will very likely discover some parasites. Examine, too, whether they are not deviating, or if one of them, as sometimes happens, has found its way into the punctum. See also if the caruncula is inflamed. Pursue your examination upon a certain system, for otherwise you are apt to confuse yourselves, and overlook some essential point, or fatigue the patient's eyes by one method of exploration, so that they will not be in a fit condition for any further examination.

When the eyes are inflamed you observe which tissue is suffering. If it be the conjunctiva you will notice the character of the discharge, whether it is stringy, muco-purulent, or purulent. When one eye is affected you will suspect that it may be a case of inoculation, and if there be no discharge you should evert the eyelid, and search for some foreign body which may be situated at its cul-de-sac. The eyelid should be everted without the aid of instruments, simply by paralyzing the orbicularis by pressure between the index finger and thumb, then lift it with a probe, and look deep into the cul-de-sac. Take also a side glance at the cornea, to discover whether the cause of irritation is not situated there, or put your finger on the inner angle, and see whether any tears or purulent secretion comes from the lachrymal sac.

When there is inflammation of the iris, choroid, or ciliary circle, you should examine the iris very carefully, and see whether there are any adhesions, noting particularly the tension of the eyeball by palpating with the two index fingers through the eyelid. In old cases of choroiditis the eyeball is generally soft, sometimes to such an extent as to mark the impression of the ocular muscles, and you may then be sure that the eyeball is useless. In cases of inflammation of the iris and ciliary circle the eyeball is sometimes harder than normal, and this so-called glaucomatous condition of the eyeball, supervening upon inflammation of the deep structures, is very serious, and calls for immediate surgical interference. Mr Bowman has introduced the following formula for the different degrees of tension of the eyeball, thus:

Tn. = Tension normal.
T. 1 = Slight increase of tension.
T. 2 = Considerable tension.
T. 3 = Extreme tension.

We may express the same by hard, very hard, stone hard.

Softness of the eyeball is indicated by – T. 1, – T. 2, and – T. 3, or soft, very soft, extremely soft; whilst in doubtful cases it is marked by T. 1 ? or where there is doubtful decrease of tension – T. 1 ?

Where there is no inflammation visible to the naked eye, and the patient complains merely of dimness of sight, you must first test his refraction and acuity of vision by means of Snellen's "test types," which you put at twenty feet distance from him. If he cannot see No. 20 at this distance it is quite possible that he is merely myopic, and you try, therefore, the concave lenses. If the concave glasses improve his vision you proceed to ascertain the degree of his myopia, which you correct by ordering him the proper spectacles; but if the concave lenses rather make the dimness worse, you try the convex lenses. If it be a case of hypermetropia you will measure the degree of this defect in his refraction, and correct it by suitable glasses. In connection with refraction you will not omit to test him for astigmatism, by means of Snellen's radiating lines and cylindrical glasses; for, from neglect of this, awkward mistakes sometimes occur. Recently, a popular clergyman brought to me his two children to be operated upon for squint. During the interview I noticed that he himself suffered from some anomaly of refraction. He then explained to me that, finding his sight deficient while a student, he had consulted an eminent oculist, who recommended him to give up study and betake himself to farming; he, however, took up the works of Thomas Young, in the 'Philosophical Transactions,' discovered from them that he was astigmatic, and providing himself with a pair of cylindrical spectacles, was then able to pursue his studies. Mr Brudenell Carter refers to similar cases of more recent date, showing that the traditional way of managing such anomalies of refraction is still in vogue.

If neither the concave nor the convex lenses improve the sight for distant objects, you will test his vision for near objects. When after correcting the anomaly of refraction visual acuity is still deficient you explore the interior of the eye by means of the ophthalmoscope, to discover what tissue is affected, whether the retina, choroid, optic nerve, or vitreous. In cases of retinal or nervous affection you will examine the eye by means of the perimeter, to determine what part of the visual field is defective or contracted. Indeed, in some cases, there may be blanks or blind spots (scotomata) in the periphery, while the central vision is not blunted, and *vice versâ*.

The exploration of the visual field, which not long ago was considered to be of secondary importance, is now very justly regarded as an essential element in the diagnosis of retinal and nervous affections.

The perception of colour of the patient should also be tested, for in some diseases of the optic nerve or in hysteria, chromatopsy is a concomitant symptom.

Children require special management. The diseases most prevalent amongst them, besides the common catarrhal or purulent ophthalmia, are strumous affections of the cornea and disease of the Meibomian follicles. The former are accompanied by shrinking from the light (photophobia). The little patients are also subject to hereditary syphilis, or a mixture of the dregs of syphilis and struma, which manifests itself in deep inflammation of the cornea and ciliary muscle. This may be an inheritance from their parents or grandparents. You will recognise the depth of the corneal inflammation by the expression of suffering imprinted upon the countenance, and by the way in which the patients carry their heads. They sometimes press their hands strongly to their eyes to exclude the faintest glimmer of light. The opening of the eyelids becomes difficult, for the orbicularis is spasmodically contracted, and the more you endeavour to get a glimpse of the eye the greater is the tendency of the eyeball to rotate upwards, and be hidden under the upper lid. The best way to get a view of the eye is to apply your finger to the brow, and make the patient look down on his own hand, and while he is in the act of doing so you raise the eyelid very gently, and thus make a more satisfactory inspection than you will ever succeed in making even by the application of the elevators.

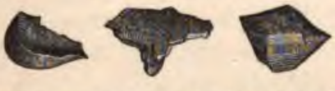
Infants are generally very troublesome, for their cries and resistance to touch enhance the difficulty inseparable from such cases. You must attract their attention with toys and such like articles, or look at them without arousing their suspicions. When you wish to examine a case of non-inflammatory affection, such as strabismus or a tumour, you must do so at a distance, or without tonching the child; but when the eye is inflamed, swollen, or sensitive to the touch, you put the infant's head on your knees, which are to be covered with a towel, and thus keep the head firm. Open the eyelids with the finger and thumb of your left hand, which you use as a speculum.

When the eyeball is hid in discharges, and the eyelids much tumefied, you use the elevator to raise the upper eyelid, and depress the lower lid with your finger. It must be remembered that the crying and resistance of the infant are themselves calculated to change the appearance of the eye and alter the symptoms.

When a foreign body has struck the eye examine the cornea, and see if there be any mark of a wound upon that membrane. Press gently with the finger upon the eyeball, and if the patient starts as if pricked you may conclude that a foreign body is lodged in its interior.

If this rule were strictly adhered to, we would meet with fewer patients with foreign bodies like these (Fig. 13) lodged in the interior of the eyes for weeks or months, who are all the time treated with orthodox washes and nostrums until sympathetic inflammation overtakes the uninjured eye.

FIG. 13.

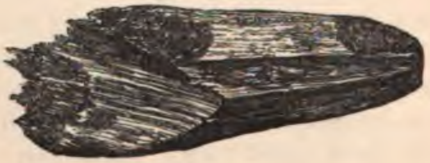


Pieces of rivets removed from the interior of the eyeball.

Follow this up by focal illumination, and see whether it be situated in the lens; then dilate the pupil and explore the interior with the ophthalmoscope. When there is a state of persistent irritation of the eye, the result of an injury, and no trace of a foreign body can be found within the eyeball, explore carefully the state of the orbit; see whether there is any bulging there, if motion of the eyeball in any direction be interfered with, or if there be any protrusion of the eyeball (exophthalmos); you should then press with your little finger or with a fine probe, to see if there be a foreign body situated in some part of the orbit; and when there is a fistula in any part of the conjunctival sac you may almost take it for granted that a foreign body is lodged within the orbit. You have only to introduce a probe, following the direction of the fistula, and you are pretty certain to find the foreign body there. It is astonishing what large bodies may be buried for a number of years within the orbit or antrum maxillaris. I reported a case from Nélaton's clinique,[1] where that surgeon found an ivory umbrella handle, cylindrical in shape, about an inch and a half in length, half an inch in diameter, and weighing 184 grains, situated in the antrum maxillaris, having penetrated through the orbit. The patient went round the hospitals, and baffled all the surgeons for upwards of three years; but when he came to the Clinique de l'Ecole de Médecine, Nélaton at once inserted a probe, touched the ivory, and then cut down and extracted it. He then pointed out the rule that "Whenever, after an accident, we find a fistula of long standing, resisting all attempts to close it, we may feel pretty certain that a foreign body is lodged there." It was this principle which enabled him, some years later, to diagnose with such certainty the existence of a bullet in Garibaldi's foot. The same principle enabled me the other day to diagnose the existence, in the upper eyelid of a miner, of a stone, which had been mistaken for a large tumour. It had been projected into the lid by an explosion, and the wound had been brought together with ligatures at the time, without the presence of the foreign body being suspected. It had lodged there for a period of six months, and had produced complete ptosis.

Fig. 14 represents the knob of an infant's chair, which Desmarres extracted from the orbit of a patient aged 31, where it lodged three months.[1]

FIG. 14.



You will be able more readily to trace the course of a foreign body in the eyeball when it has recently penetrated it than after it has set up some mischief in the deep structures.

Sensitiveness to touch may be developed during protracted disease of the deep tissues, and when the eyeball is touched careful notice should be taken of its condition in this respect. Dr. Carmichael, of Glasgow, consulted me in April, 1877, in the case of a lady aged 55, who, whilst under treatment by a confrère for the disease of one eye, the sight of which was completely gone, had been alarmed to find that of the second eye becoming hazy. On touching the blind eye, I found it, although apparently quiescent and presenting no sign of active inflammation, yet tender to the touch in some directions. I ordered its removal immediately, and then found the equatorial part of the eyeball constricted, so that it had acquired somewhat the appearance of a sand-glass. On opening it, it was seen to be full of sarcoma. Notwithstanding the enucleation, sympathetic ophthalmia still made rapid strides; the other eye had a hard struggle for life, and the patient remained under active treatment for three months before any improvement could be noticed. A thin, false membrane is still visible in the area of the pupil. Sight tolerably good.

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[1] 'The Lancet,' Dec. 17th, 1859.

At present I have under treatment a titled gentleman, aged 75 years, who was suddenly seized with inflammation of his right eye in November, 1880, and last week (April, 1881) I found the cornea flattened, the limbus of the sclerotic puckered, and on touching it there was decided tenderness on pressure. I recommended the eyeball to be removed, and on opening it Dr. Foulis found a sarcoma filling the anterior hemisphere, commencing at the ora serrata and involving the whole uveal tract; the cornea, although flattened, was thickened to four times its normal condition.

There is reason to fear that, tenderness to pressure on the eyeball is very little attended to, because it is not insisted on by systematic writers. When a blind eye is sensitive to the touch, that is a symptom which calls for its removal, because there is either bony degeneration of the tissues, or sarcoma, or some other mischief, which renders the occurrence of sympathetic inflammation extremely probable.

Let me here remind you that the study of ophthalmic medicine and surgery—thanks to the labours of so many scientific workers—has now almost been raised to the dignity of an exact science, and that therefore the diagnosis of any case is not mere guess-work. What were some years ago regarded as

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[1] 'La Clinique Européenne,' Jan., 1859.

shrewd guesses we can now treat as well-ascertained pathological tissue-changes, and this you ought always to remember in your treatment of eye-diseases. You must not depend upon the dicta of authorities, but, even in the early stage of your practice, cultivate the habit of self-reliance, by careful reflection on the course you are to pursue. Do not let Schiller's words—

> "Den Mann muss man verachten
> Der nie bedenkt was er vollbringt,"

apply to you in your practice. Never administer medicine, and, especially, never use your instruments to perform any operation upon the human eye, simply because that treatment has been recommended by such and such an authority, however great. Many things are done in our art which are tentative; weigh carefully any dogma before you put it into practice on the human organ. In so doing you will be the propagators of those doctrines only, which will live in science. Bear in mind that the state of the science and the prestige of medicine and surgery in the future depend on your exertions.

In the performance of any operation, three things must be specially insisted on :—mathematical precision and neatness of manipulation, and the most scrupulous cleanliness. If you cultivate those habits in this department, you will find them a constant help in your general practice.

LECTURE III

THE CONJUNCTIVA

GENTLEMEN,—The conjunctiva is a mucous membrane which lines the eyelids and covers the eyeball in front, and thus when the lids are shut has the appearance of a closed cavity. It consists of a dense layer of connective tissue—papillary membrane—corresponding to the cutis, with stratified epithelium consisting of slightly nucleated cells on its surface.

Commencing at the free border of the eyelid, where it is fringed with eyelashes, it lines the posterior surface of the so-called tarsal cartilages,[1] and then, making a cul-de-sac, is reflected upon the anterior part of the sclerotic to the cornea, where it is imperceptibly blended with the superficial layer of that structure. The conjunctiva is accordingly divided into palpebral conjunctiva (conjunctiva palpebrarum), ocular conjunctiva (conjunctiva oculi) and the conjunctiva of the cul-de-sac.

The palpebral conjunctiva is a reddish membrane, and, according to Kölliker, is very intimately connected with the posterior surface of what was formerly described as the tarsal cartilages, whilst W. Krause describes a very thin layer of connective tissue as intervening between it and the tarsi. The Meibomian glands, twenty or thirty in number, are embedded in grooves in the eyelids and open in the free margin of the lids by minute orifices. In the normal condition these glands are seen running as yellow vertical lines through the conjunctiva, with red lines intervening, but when the conjunctiva is inflamed they are obliterated by a velvety or granular appearance of the whole surface. The conjunctiva oculi is white, less dense and thick than that of the lids, and is loosely attached to the sclerotic by a large quantity of connective tissue and some fat globules.

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[1] The structure called tarsal cartilage is only a modification (condensation) of subconjunctival tissue, and an integral part of the mucous fold.

At the cul-de-sac there are small racemose mucous glands and the trunks of blood-vessels. At the edge of the cornea the conjunctiva forms a slight circular elevation (limbus conjunctivæ), well marked in some old people. At the inner angle of the eye there is a semilunar conjunctival fold (plica semilunaris) corresponding to the *membrana nictitans* in animals, with a rounded elevation—*caruncula lachrymalis*, containing about a dozen fine hairs.

The lachrymal gland, for the secretion of tears, is situated at the upper and outer angle of the orbit; its secretory ducts, from six to twelve in number, penetrate the conjunctiva between the outer part of the upper eyelid and the ball. The lachrymal gland, however, is not the only organ for the secretion of tears. I have repeated the experiment of Bernard, and convinced myself that tears continue to flow even after the extirpation of the gland in animals, and that the conjunctiva itself secretes a considerable quantity. The use of the tears seems to be to preserve the transparency of the cornea by washing away the superficial layer of epithelium, for otherwise the cornea would become opaque, as in the disease called *xeroma*, or dryness of the conjunctiva. The tears secreted by the conjunctiva and lachrymal gland are partly evaporated and partly sucked up by the upper and lower canaliculi, to be conveyed away into the posterior nares by the lachrymal ducts.

INFLAMMATION OF THE CONJUNCTIVA

Ophthalmia Neonatorum—Purulent Conjunctivitis—Gonorrhœal Ophthalmia.

In my inaugural address, delivered at the Andersonian University about twelve years ago, I stated that, from the examination of the inmates of the Asylum for the Blind in Aberdeen and elsewhere, I found that a large number of the incurable blind owe their misfortune to purulent ophthalmia of infancy — a disease almost invariably destructive in its tendency when unchecked, but which is under the control of proper treatment. I urged upon medical practitioners the importance of abandoning the treatment then in vogue; but I find that the old routine practice is even now pretty generally pursued.

To emphasise its importance to you as medical practitioners I shall give this affection the most prominent place among the diseases of the conjunctiva.

On the third or fourth day after birth your attention is called to the infant's eyes. You find the lashes stick together, and hard crusts form at the borders, which are red. First one eye is affected, then the other. In such a case you should suspend your judgment with regard to the nature of the disease, for it may be only a catarrhal attack, which will pass off in a few days. The next day you find the redness and swelling increasing, the lid more swollen, and the conjunctival sac filled with transparent, yellowish-coloured serum and mucus. then you need have no doubt that you have to deal with a most dangerous and destructive form of conjunctivitis. The redness and swelling go on increasing, and on lifting the eyelids some drops of pus come out. In about a week the swelling of the conjunctiva and the engorgement of the vessels increase, and there is a copious discharge of pus, which runs over the cheeks of the infant, while the swelling of the palpebral conjunctiva and of that of the cul-de-sac presses on the eyeball, so that there is a difficulty in opening the lids, and, when opened, the cornea is hid and retracted in the purulent discharge.

Cause.—What has taken place is this. The child in its passage from the uterus had its eyes inoculated, most likely with gonorrhœal, possibly with leucorrhœal, or other discharge from its mother's genital organs. You know when a mucous surface with lamellated epithelium, like the urethra or conjunctiva, is inoculated with pus, a process of proliferation of the epithelium ensues. The epithelium is transformed into pus-cells, which are thrown off, and it is rapidly reproduced to be again turned into pus, or, to use the words of the eminent author of this doctrine: "The real state of matters is exactly the reverse of what was formerly imagined to be when a solvent property was ascribed to pus. Pus is not the dissolving, but the dissolved, *i.e.* the transformed tissue. A part becomes soft and liquefies whilst suppurating, but it is not the pus which occasions this softening; on the contrary, it is the pus which is produced as the result of the proliferation of the tissue."[1] This is effected without the slightest ulceration of the surface, on account of the several strata of cells, the upper forming a kind of protection to the deeper ones. This suppuration may go on for two or three weeks until the reproduction of the epithelium cannot keep pace any longer with the pus formation; then the covering becomes imperfect, the conjunctiva and the subconjunctival tissues are attacked at the limbus, ulceration or abcess of the cornea ensues, ending in perforation, the eyeball bursts, the lens is evacuated, and the ball shrinks. This is particularly the case when the lid becomes tense upon the ball, impeding the circulation. Should the eye escape disorganisation, as in some of the milder attacks, opacity of the cornea is left behind, causing strabismus, amblyopia, nystagmus or opacity of the lens-capsule (capsular cataract).

Stellwag is of opinion that, because the eyes of the child are closed during parturition, and are also covered by sebaceous materials, inoculation at that time is scarcely possible; hence he thinks it more than probable that bright light on the eyes of the newly born induces this form of ophthalmia. He also holds that sudden changes of temperature may produce it; but that the most common source of the affection is the impure air of a room filled with foul exhalations, smoke, dust, or acrid vapours, as well as the musty dampness arising from want of ventilation or uncleanliness of the clothing and body of the child, and of the hands of the attendants.[2]

This view, however, will not be borne out by the experience of general practitioners. This form of ophthalmia is very rare in the filthiest localities, and when cases do occur there is always a gonorrhœal history or genital discharge connected with them. In our own experience we are never without some cases of purulent conjunctivitis of infants from the "Home of Deserted Mothers," where great attention is paid to cleanliness; and when I am consulted in cases in private practice I find it almost invariably connected with blennorrhagia. There can be no doubt, however, that purulent conjunctivitis may be produced by inoculation from other discharges.

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[1] Virchow's 'Cellular Pathology, p. 446, Chance's translation.

[2] 'Treatises on Diseases of the Eye.'

CASE.—I was asked by the late Dr Dickson to see his grandchild, a girl of three years of age, who had been troubled with a serious form of inflammation of the right eye for four or five days. I found the conjunctival sac filled with a yellowish ichory discharge, not like the creamy discharge in infantile ophthalmia. I had no doubt that it was a case of inoculation. On inquiry I found that the nurse was suffering from ozæna, and bloody pus from her throat and nostrils was found upon the pillow. The smell was so offensive that every morning the window had to be opened before the lady could enter the nursery. As the child was the nurse's bed companion there could be no doubt how the disease originated. The case did well after ten days' treatment.

Treatment.—Our endeavour must be directed to prevent the cornea from being involved in the morbid process. The deleterious treatment above referred to consists in dropping an aqueous solution of Argenti Nitras (gr. x to ℥j) into the eye. The effect is either that the pus washes away the solution, rendering it innocuous, for it never reaches the diseased surface, or it irritates the cornea, denuding it of its protecting epithelium; the cornea ulcerates, or an abscess is formed leading to disorganisation. During this period the swelling of the eyelid increases to such an extent that an examination of the eyeball is impracticable, and when the swelling abates, and the surgeon is able to see the ball, he finds that the eye is gone. To use the pithy history which mothers give of the case: "The eyes were so swollen that the doctor could not get a glimpse of them, and when the swelling fell, and it opened its eyes, we found that there were no eyes at all."

Argenti Nitras is a valuable remedy, but a two-edged sword. I am so strongly impressed with the havoc which it does to infants' eyes that I very rarely use the solution in my clinique, for fear lest some of you should carry away a vague notion of its application, and be the means of doing mischief.

The course which we adopt is:

1. When we happen to see the case in the first stage, before the purulent discharge has set in, I make the patient's head be reclined upon my lap upon a towel, where it is secured. I evert the lids, either both together, or first the upper and then the lower, and after cleaning them with dry lint touch the conjunctival surface with lint dipped in a borax lotion;[1] then put a few drops of the solution of atropine upon the conjunctival surface.[2] The application is repeated three times a day. The atropine has an antiphlogistic effect upon the inflamed surface, and also, by dilating the pupil, relieves the tension of the eyeball. I never use cold applications, which are recommended by some, neither do I apply ointments of any kind to keep the lashes from sticking together, which, I think, is best effected by washing with warm milk. Dry lint is then applied to the lids, and secured by an immovable bandage, and the case is carefully watched from day to day.

2. When I see that it is an unmistakable case of purulent ophthalmia I proceed to the following course:—The patient's head is put upon my lap, I evert the upper lid, then the lower, and having cleaned away the pus by means of dry lint, drop in a little of the solution of atropine; then I touch the surfaces with an amalgam consisting of Argenti Nitras two parts and Potassæ Nitras one part, and again put a few drops of atropine upon the cauterised surface.

When the conjunctival surface is bleeding (which I regard rather as a favorable symptom) I dry it with lint, and repeat the cauterisation, touching the whole of the conjunctiva, and also the cul-de-sac; then I bathe it with lint dipped in warm water, and cover the eyes with dry lint and a bandage. When one eye is affected I close the healthy eye with two strips of court plaster, and cover it with lint.

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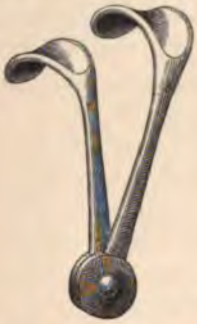
[1] ℞ Sodæ Biboratis, ʒss;
Vini Opii (1864), ʒss;
Aquæ Lauro-Cerasi, ʒiij;
Aquæ Puræ, ad ℥iv.
Solve, et cola per chartam.

[2] ℞ Atropiæ Sulphatis, gr. j;
Aquæ Destillatæ, ʒij;
Glycerine (Price), ʒss.
Solve, et cola per chartam.

3. When you are called to see a case in an advanced state of suppuration—say of three or four weeks' standing—you must take care in opening the eyelids, for the eyeball may be just on the point of bursting, and the effort to lift the lids and the spasm of the orbicularis may be the means of hastening on the inevitable, for which you will get the entire blame. You had better open it by means of the elevators (Fig. 13), with which you raise both eyelids, or if you have only one instrument you raise the upper one, without pressing upon the globe.

I must, however, caution you on the subject of instruments. The great majority of people with whom we have to deal, especially in country districts, entertain a large amount of ignorant prejudice against their use, and may ascribe to them any unfortunate termination of the case. On one occasion, when I had to use the elevators in a case in the country, the mother rushed from the room, crying that I was turning the child's eye inside out.

FIG. 14.



Desmarres' elevator, modified by me for the pocket, of two sizes.

If you find the cornea intact use the atropine and the nitrate pencil. The apprehensions expressed by an eminent authority,[1] lest the application of the nitrate pencil might give rise to inflammatory mischief, diphtheritic-like patches, &c., is well founded, if you rub on the caustic without thinking what you are about. Touch the conjunctiva very gently, just passing lightly over the epithelial surface, for otherwise you will produce an eschar or loss of substance and a cicatrix, which it is your object to avoid.

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[1] Stellwag.

4. When an ulcer of the cornea or an abscess has already formed, or even when all the layers of a portion of the cornea are destroyed, with the exception of the Descemet membrane, which protrudes through the ulcer in the form of a corneal vesicle (keratocele), and is the only bar to the exit of the aqueous humour, then it becomes more urgent to proceed energetically with the application of the nitrate, which is the only efficient weapon to combat this disease. We generally manage to arrest its progress and save the cornea, even if we have found it in the process of softening or with abscess.

In May, 1880, I was asked by Dr Sloan, of this city, to see a patient of his, an infant four weeks old, which in his absence was treated by some one who had delivered the mother. I found the left eye totally destroyed, and the right with a purulent discharge and abscess at the lower corneal segment, and I adopted the course of treatment just indicated, visiting the child daily. After a week's treatment we thought we might see the patient at longer intervals, and were disagreeably surprised to find that there was a relapse; the discharge recommenced. I had, therefore, to resume assiduous attention, and we were pleased to find that, even at that critical juncture, we saved, at least, one useful eye to the infant. Such cases you must see daily. In public hospitals or dispensaries Sundays must not be excepted, for one day's neglect may prove disastrous.

Modus operandi.—The old method of applying the caustic solution was based upon the conception that we substitute one kind of inflammation to drive away the old one. Homœopathy has not been slow in deriving from it one justification of its "*similia similibus*" dogma. But this is not the principle on which we act. What we actually do is this: we produce a fine coating of the nitrate upon the superficial epithelial layers in order to give the new layer time to be formed under cover, as it were, without being exposed to pus metamorphosis.

Gonorrhœal Ophthalmia

Persons suffering from gonorrhœa sometimes inoculate their conjunctiva by touching it with their fingers, or with a dirty towel used in dressing, or the disease may be induced by using a towel soiled by some one else who has a urethral discharge. Most frequently the right eye is affected. Women are rarely subject to it.

Treatment must be very prompt. Warm fomentations should be used, and a weak solution of lunar caustic painted with a camel-hair pencil over the palpebral conjunctiva, and washed off with another pencil dipped in a solution of chloride of sodium. When the discharge gets more abundant we must have recourse to the same treatment as in infantile ophthalmia.

Some eminent authorities, as Desmarres and von Graefe, recommend the application of twenty or thirty leeches to the inner angle of the eye and temple, and friction with Unguent. Hydr. Fort. and Bellad. over the eyebrows. I have no objection to the Unguent., followed up with small doses of blue pill with quinine; but I must confess that the leech has only a zoological interest for me; I could never see its applicability to eye affections. Rest to the eye and body is absolutely necessary. I need hardly remind you that the prognosis is more serious when the urethral discharge is complicated with chancre. In that case, indeed, you will find, after five or six days, that the limbus has an appearance of constriction, as if a cord were drawn round it; the aqueous chamber becomes narrower, and presents a peculiar glassy look, and then collapses. No course of treatment can save such an eye from disorganisation.

CONJUNCTIVITIS

The different forms of inflammation of the conjunctiva, besides those which are the results of inoculation, are comprised under the following heads:

1. Hyperæmia.
2. Catarrhal.
3. Purulent.
4. Granular.
5. Pustular and exanthematous.
6. Diphtheritic.

It will simplify your study, if you bear in mind that, the gravity of the inflammation is commensurate with the depth of the conjunctival layer affected. For instance, if you consider simple *hyperæmia* of the conjunctiva as the expression of irritation of the epithelium, *catarrhal* as inflammation of the conjunctiva proper, and what is called acute suppurative inflammation as that process which extends to the subconjunctival membrane, &c., you will have a clearer notion of the subject than our present somewhat confused nomenclature is apt to convey to your minds.

HYPERÆMIA

As a type of this affection you may take the case of irritation of the conjunctiva by fine particles of dust lodged in the conjunctival sac. There is redness with slight swelling of the membrane, and enlarged papillæ over the Meibomian glands give the whole palpebral conjunctiva a red velvety appearance, which may extend to the cul-de-sac, to the inner angle, or even to the ocular conjunctiva. There are smarting and itching in the eye, according to the natural sensitiveness and according to the tension of the eyelid, whilst an inclination to winking and a feeling of friction are felt over the surface. Now and again the patient thinks he has got rid of the annoyance, but the sensation of friction comes back at intervals. There is slight lachrymation when exposed to wind and bright light, but there is no discharge.

2. The same condition may be induced by the encroachment of a few fine eyelashes upon the eyeball. These supernumerary hairs, situated at the free margin of the lid, are sometimes so small that you must evert the border and look for them in an oblique direction in a good light, as otherwise they will escape your notice, and you will misdirect your treatment. I have met with cases of misdirected treatment by surgeons of great repute, who evidently did not take the trouble to make a careful examination.

3. I may mention another cause which sometimes produces a protracted state of hyperæmia, namely, white, round particles of calcareous deposits embedded within the conjunctival substance. They are concretions from the Meibomian glands, tear-

stones (Dacrolythes), and may be the size of pins' heads or larger.

4. Obstruction of the tear passages, the hypersecretion of tears (Epiphora) or disease of the Schneiderian membrane with that of the air-passages, may give rise to the same affection.

5. In hypermetropic or astigmatic persons, who have to strain their accommodation, hyperæmia may be induced, and, if aggravated, may become the concomitant symptom of retinal hyperæmia.

Treatment.—You will of course first remove the cause. Evert the eyelids and seek for a foreign body or concretions and remove them, pull out the eyelashes, correct the tear passages. You may bear in mind this rule, that when one eye only is affected it is generally owing to a local cause. Supply suitable glasses for deficient refraction. Let the patient avoid public meetings, heated rooms, and strong gaslight. If the affection has been induced by exposure to strong fires, recommend slightly blue spectacles. Bathe the eyes with Infus. Anthemidis nobilis, or with a zinc or alum lotion in warm water.[1]

CATARRHAL CONJUNCTIVITIS

When we advance a step higher than hyperæmia, we arrive at catarrhal conjunctivitis. The disease is characterised by a discharge of a morbid secretion (κατἅρέω) of the conjunctiva. It is caused by suppression of perspiration, getting a cold after being heated, or any similar condition. In a paper which I published[2] I considered it as a form of erysipelas of the conjunctiva, and regarded its genesis, like most causes of erysipelas, to be traumatic, dusty particles in the air lacerating the epithelial surface. There is no doubt, however, that atmospheric causes are important factors in the disease.

Local symptoms.—The blood-vessels are more injected and developed than in hyperæmia. There is enlargement of the papillæ, producing the same velvety palpebral conjunctiva, only in a higher degree. There is more or less serous infiltration of the conjunctival cul-de-sac, whence a large number of scarlet-red blood-vessels proceed to the eyeball as far as the cornea. Red ecchymotic patches of extravasated blood are situated upon the ocular conjunctiva. The eyelids become slightly red and swollen at the angles. The discharge in the first stage is only tears, then mucus (*i.e.* albumen mixed with imperfectly formed epithelial cells), which accumulates under the lower lid and covers the cornea, causing momentary dimness of vision. The mucus then acquires a yellowish-red tinge, and with the progress of the disease becomes mixed with pus-cells. The muco-pus appears in the form of strings under the lower eyelid and in the inner angle of the eye, and is quite different from the blennorrhagic discharge, which is of a creamy consistence. During sleep the secretion evaporates, leaving a residuum of hard, brittle crusts, which glue the eyelids together. In children with fine skin the irritation of the secretion gives rise to eczema of the face.

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[1] ℞ Zinci Sulphatis, gr. v;
Aquæ Rosæ, ℥j;
Aquæ Puræ ad ℥iv.
Solve.

or ℞ Alumnis Sulphatis, ʒss;
Aquæ Lauro-Cerasi, ʒiij;
Aquæ Rosæ, ʒv;
Aquæ Puræ ad ℥iv.
Solve, et cola per chartam.

[2] 'Medical Times and Gazette,' April, 1876.

General symptoms.—The eyes feel hot and itching, and this feeling increases at night and in artificial light. There is a sensation as if some foreign bodies were lodged in the eyes, accompanied with difficulty of opening the lids. Temperature is not increased.

Under proper treatment the whole train of symptoms disappears without leaving any trace behind. Mild cases, indeed, may end in resolution without any treatment; but the severer forms, when neglected, may leave behind a chronic condition, which consists in the retreat of the disease to the palpebral conjunctiva and to the cul-de-sac, which presents a rich velvety appearance, with occasional redness at the inner angles. The chronic form is very troublesome; it may continue for months, especially when the patient is exposed to a vitiated atmosphere, and it may give rise to *follicular* conjunctivitis, *i.e.* hypertrophy and formation of lymph-follicles upon the palpebral conjunctiva, giving a sort of raspberry appearance to the surface, which is rich or livid in colour. The secretion in this form is more contagious than the catarrhal discharge.

Treatment.—In mild attacks the infusion of Anthemidis nobilis or Collyrium Sulphatis Zinci is sufficient. In severer forms of inflammation I generally order a bichloride or borax lotion[1] mild aperients, foot-baths at night, light diet, and pure air.

When follicles have formed, I evert the eyelids and touch them with lint dipped in a strong solution of borax, or with a pencil dipped in Solution Argent. Nitrat. grs. v to ℥j.

Purulent Conjunctivitis

What is generally classed by authors as purulent conjunctivitis, is only an aggravated form of acute catarrhal conjunctivitis; whilst in catarrhal the inflammation is limited to the conjunctival epithelium—the rapid reproduction of the epithelium does not allow of its proper formation, hence mucus, in purulent conjunctivitis the inflammation extends to the conjunctiva proper, and to the subconjunctival tissues. The cell formation is effected with great rapidity, and muco-pus is produced. The discharge, even in this form, is not creamy pus, but stringy and mixed with epithelial cells. The implication of the subconjunctival tissue produces serous chemosis and a greater degree of swelling of the whole conjunctival sac; the semilunar fold is swollen, the eyelids and the puncta lachrymalia are not applied to the eyeball, but are slightly everted and cannot suck up the tears, which therefore run down the cheeks. There may be corneal complications—not the same serious complications as in infantile ophthalmia or in gonorrhœal—but pustules or ulcers may form at the limbus. These, when neglected, may become chronic, and lead to corneal opacity, according to the depth of the conjunctival tissue involved. It is accompanied with a great deal of ciliary pain, indicating the irritation of the ciliary nerves.

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[1] ℞ Hydrargyri Bichloridi, gr. iv;
Vini Belladonnæ, ʒiij;
Aquæ Lauro-Cerasi, ʒiij;
Aquæ Rosæ, ʒij;
Aquæ Puræ ad ℥iv.
Solve, et cola per chartam.

[2] ℞ Sodæ Biboratis, gr. xv;
Vin. Belladon., ʒiij;
Aquæ Rosæ, ℥j;
Aqua ad, ℥vi.
Solve, et cola.

Bathe the eye with a tablespoonful, in a little warm water, three times a day.

In cachectic subjects or in crowded localities it may even degenerate into granular conjunctivitis, and it is this circumstance which has given rise to the confusion of nomenclature, even Desmarres to some extent confusing suppurative with granular conjunctivitis.

Catarrhal discharge, in its most aggravated forms, though considered not contagious, becomes so when the secretion is purulent; but you must not rely upon the innocuity of any discharge. In practice you must suspect every inflammatory product or secretion as contagious, for its effect depends upon the soil to which it is transferred.

I have little to add with regard to the treatment. The only risk of corneal complication arises from subconjunctival engorgement or serous chemosis; hence you must give vent to the accumulated serum in the conjunctiva of the globe by free incisions with scissors. The immediate relief to the patient and the improved appearance of the eye after the operation are really remarkable.

PHLYCTENULAR OR PUSTULAR CONJUNCTIVITIS

Pustular conjunctivitis is an exudation under the conjunctival epithelium in the form of small vesicles, pustules, or papules, the size of a pin's head or millet seed, which have their seat most frequently at the limbus, where they surround the cornea like a string of beads. They are either transparent or of a yellowish colour, and have an elevated surface, or are in an ulcerative condition. The conjunctiva and subconjunctival vessels are injected, and from these a triangular plexus of vessels proceeds towards the pustules to repair the diseased part, and these nutritive restitutional vessels disappear when their work is accomplished. The ulcerative pustule may involve the sclerotic, and induce serious complications to that membrane and to the deeper structures, resulting in staphyloma.

Symptoms.—When the pustule is superficial there is neither photophobia nor lachrymation; but when the deeper structures are affected these symptoms are present, and sometimes also shooting ciliary pain and swelling of the lids. When the pustules are encroaching upon the cornea a network of vessels is formed at the limbus, and proceeds to it.

Treatment.—The yellow ointment (Pagenstecher's),[1] size of a pin's head, to be applied to the pustule. This ointment we keep in a glass syringe, which can easily be manipulated, without fear of the contents being spoiled by exposure. In the severer forms you may add four grains of sulphate of atropine to one ounce of the ointment (Unguent. Flav. c. Atropiæ[2]).

EXANTHEMATOUS AFFECTIONS OF THE CONJUNCTIVA

Measles, scarlet fever, smallpox, and chicken-pox, are sometimes accompanied by conjunctivitis. It proceeds from irritation of the skin of the face, hairy scalp, or Schneiderian membrane, so that, strictly speaking, it assumes the character of a catarrhal and a pustular affection. You are aware that, whenever there is an eruption of any part of the integuments supplied by the fifth nerve, you may get pustules of the conjunctiva or cornea, according to the depth of the original affection.

In measles the conjunctiva is affected generally before the skin eruption appears, and in conjunctivitis arising in connection with this exanthem or with scarlet fever we find the conjunctiva congested, followed by photophobia and lachrymation, pustules forming upon the conjunctiva, and sometimes upon the cornea. There are coughing and sneezing, the lids become redder, the photophobia increases, and meshes of vessels are directed to the place where pustules are formed. When situated upon the cornea the pustules may end in circumscribed ulceration of that membrane.

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[1] ℞ *Hydrargyri Oxidi Præcipitati, ʒj;
Olei Amygdalæ Dulc., ʒj;
in Ung. Simplicis, ʒvi.
Misce.

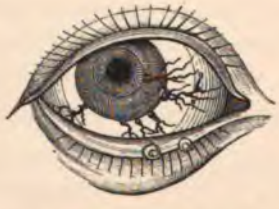
[2] ℞ Ungt. Flavæ, ʒiiss;
Atropiæ Sulphatis, gr. j.
Dissolve the sulphate of atropia ten minims of water and mix thoroughly with the ointment.

* This precipitate is formed by adding a solution of caustic soda, or caustic potash, to excess, to a solution of bichloride of mercury, washing until it ceases to give a precipitate with nitrate of silver, and then drying it on a water-bath.

In smallpox the eye affection is more serious, because it participates in the grave nature of the disease, which is more aggravated here, inasmuch as, owing to the condition and swelling of the eyelids, we are unable to watch its progress, and to direct our treatment with precision. We have hardly ever a fair chance of properly examining a variola pustule on the cornea. I think, with Desmarres, that no variola pustule really forms upon the cornea, for if it were so, few smallpox patients would escape with transparent corneæ, whilst, in fact, corneal opacities are rare in pitted cases of smallpox. I think, therefore, that corneal opacities and complications are owing to neglected treatment of common pustular keratitis at a critical period, when the system is in a low state of vitality favourable to ulceration.

In *chicken-pox* conjunctival inflammation follows the formation of styes, and sometimes the formation of small abscesses in the palpebral conjunctiva at the borders of the eyelids begins before the eruption. Fig. 14 represents the eye in a case of chicken-pox with phlyctena at the limbus and cornea, and abscesses in the eyelids.

FIG. 15.



Treatment.—No astringents of any kind are to be employed. Solution of atropine and infusion of anthemidis are sufficient. When abscesses form upon the border of the lids they should be opened at once, and not left to be absorbed. The process of metastasis is quite applicable here, and when you leave these abscesses to heal in one place they are sure to mak appearance somewhere else, either in the same eye o fellow.

When an abscess forms upon the cornea it must touched, for it is generally of the asthenic type. We n then meet with extensive corneal necrosis as a se chicken-pox.

LECTURE IV

GRANULAR CONJUNCTIVITIS—EGYPTIAN OPHTHALMIA—TRACHOMA

GENTLEMEN,—In speaking of catarrhal conjunctivitis I stated that in cachectic subjects or in a vitiated atmosphere an acute attack may pass into a follicular form; but the inflammation may, under certain conditions, appear in a still higher degree of development. Thus, in Egypt and in other malarious districts, or in poorhouses and asylums with an atmosphere loaded with organic impurities, the disease may assume a different character, viz. granular conjunctivitis.

Symptoms.—The lids are red and swollen, the conjunctiva and subconjunctival tissue are injected and covered with coarse, dusky blood-vessels; there is photophobia, and scalding tears flow down the cheeks, while a slight discharge of dark, yellowish-brown pus is secreted from the surface of the conjunctiva.

On everting the lids we find the palpebral conjunctiva and cul-de-sac studded with rough granules, resembling boiled sago, which can easily be squeezed out. These rough granules—trachoma (τϱαχός, rough), are characteristic of the disease, and are deposited partly under the epithelium and partly in the deep conjunctival tissue of the lids and the cul-de-sac. They are no new formation, but hyperplasic inflammatory products and fibro-albuminous exudations, which may invade the conjunctiva either primarily or be the sequela of a purulent attack. The granular stage is the chronic, indolent condition of the disease, the acute being the purulent stage, and between these conditions there is a subacute or mixed form.

The disease is highly contagious, and when it involves deeper structures is apt to leave behind conjunctival cicatrices and fatty degeneration of that membrane. It may also involve the connective tissue called tarsal cartilages, producing entropion (turning in of the eyelids), and by friction of the rough surface of the upper lid upon the cornea give rise to a coarse pannus (pannus crassus) upon the upper segment of the cornea, called trachomatous pannus. Indeed, whenever you see the upper segment of the cornea vascular, evert the eyelid and look at the cul-de-sac, and you will generally find sago granules in that region. Or it may end in xeroma—dryness of the conjunctiva, and degeneration and rupture of the cornea.

The division made by writers of this disease into *true* and *vesicular* granulations is quite unintelligible, and I do not think that there is any reason for regarding the suppurative granulations as Egyptian ophthalmia, and the indolent form as granulations, for these are merely different degrees of activity of the same disease. The indolent form may at any time rise to the suppurative stage, just as the suppurative granulations may retrogress into the vesicular form. Both eyes are, as a rule, affected; but cases occur in which the disease is situated in one eye only.

This disease was well known among the ancients, but it is generally supposed that it was first imported into Europe from Egypt by the French army in 1798; hence the name Egyptian ophthalmia. Since that time it has spread and become endemic amongst us; and, when it invades barracks, has caused great havoc amongst the army. This was also the case in Belgium in 1836, when the government of that country appointed a commission to deal with "military ophthalmia," as it was called.

Great diversity of opinion prevails among authors with regard to this disease. If you read the two excellent articles on the subject, one by Saemisch,[1] and the other by Warlomont, who devotes a long chapter to military ophthalmia in his translation of Mackenzie's work,[2] you will see the essential divergence of the views held by these writers, and that the translator differs from the author. It was owing to this difference of opinion among authorities that the Belgian Commissioners were selected from among those who had never published their views with regard to it.

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[1] 'Handbuch der Augenheilkunde.'

[2] Warlomont et Testelin,' vol. i, pp 697—756.

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Treatment.—In the first stage of the attack warm poultices, as recommended by v. Graefe, are of great use, because they promote suppuration and the discharge of the impurities which cause and propagate the disease; but when the affection is of some standing and confirmed, when the granulations are freely embedded in the conjunctiva of the eyelids, and friction has produced corneal vascularity, softening, and pannus, many plans of treatment have been resorted to. Sulphate of copper used to be, and I suppose is still considered, the standard remedy for granulations, for in every case of Egyptian ophthalmia, out comes the bluestone, mechanically, as it were. I have seen patients rubbed with bluestone for eight or ten years, until no trace of transparent cornea was left; and I have never seen any satisfactory result accruing from the use of Argentum Nitras, or any other caustic.

Inoculation with blennorrhagic pus is highly spoken of as a curative agent by competent authorities, and it is said to have removed, in many cases, the pannus, and restored corneal transparency. From the favourable reports by eminent surgeons, there can be no doubt that some cases have been cured by means of inoculation, but speaking from my own experience I must say that, as I have never seen what I can call a cure, I have not availed myself of this remedy. One case, indeed, which occurred in my own practice, did not tend to encourage me to adopt it.

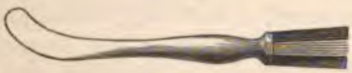
Case.—A boy who was being treated for trachomatous pannus of both eyes had one eye accidentally inoculated with gonorrhœal pus from a fellow lodger. Corneal suppuration and destruction was the result, while the other eye, which escaped inoculation, completely recovered under treatment. Of course this is a solitary case, and ought not to weigh against the accumulated evidence in favour of this remedy; and it must also be borne in mind that pus for inoculation of trachoma is taken from the discharge of an ophthalmia neonatorum, which is not so virulent in its effects. "It is applied by means of a probe, and left alone to do its work, but must be watched most carefully."

My principal reason for not trying inoculation is that the course of treatment which I adopt is very satisfactory in its results. Since March, 1871, I have discarded all the ordinary remedies in vogue, and adopted a uniform method, from which I have seen no reasons ever to depart, and this consists in the use of—

(1) Scarification.
(2) Syrup of tannin.
(3) Friction.
(4) Solution of atropine.

Given a typical case of granular conjunctivitis with pannus, I evert the upper and lower eyelids, and with Desmarres' scarificator (Fig. 16) make free incisions into the conjunctiva of the eyelids, including the cul-de-sac. The incisions are only sufficiently deep to allow free exit to the sago-like deposits, without encroaching on the tarsal surfaces, and with the fingers I gradually squeeze out the granules. The surfaces being sponged with warm water to encourage bleeding, a solution of atropine is applied to the part, followed up with borax lotion three times a day. Two days afterwards the eyelids are again everted, and syrup of tannin poured upon them;[1] the lids being drawn forwards, the conjunctival surfaces are then rubbed against each other with the view of disintegrating any of the deposits which may still remain. The scarification is again resorted to in a fortnight or three weeks, if necessary, according to the exigencies of the case, but the syrup of tannin is applied with friction every second or third day. By these means the granulations are got rid of, and the thickening of the pannus disappears, the cornea gradually recovering its transparency.

FIG. 16.



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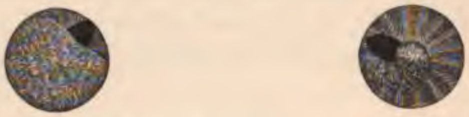
[1] ℞ Acidi Tannici Pur., ʒij;
Syrupi Simplicis, ℥j. Misc.

Place in a glass flask, and apply heat until a clear solution is formed. Apply few drops to the conjunctival sac.

At the meeting of the British Medical Association, held in Edinburgh, in August, 1875,[1] I showed one case of double extraction of cataract after cure of granulations, and another case of traumatic cataract, also complicated with granular conjunctivitis and opacity of the upper segment of the cornea, successfully extracted after getting rid of the granulations. At the same time I brought under the notice of the section a case, of which the following is a report:—Fig. 17 represents the case of N. M'N—, aged 48, a plasterer, who was for upwards of ten years under treatment for Egyptian ophthalmia, resulting in trachomatous pannus and in changes in the deep and neighbouring structures of both eyes. When he came under my care two years ago the right eye was rendered completely opaque by a thick cicatrix extending over the whole cornea, with the exception of the inner segment, the eyelids were inverted, and the friction of the lashes increased the mischief; the left eye had also a central corneal cicatrix, which covered the whole of the pupil. This was a genuine type of Egyptian ophthalmia of a most aggravated form; and in addition to a heavy crop of sago-granules, there was present the puriform discharge, which recurred at intervals. The structural changes in the cornea and eyelids are sufficient indications of the severity of the affection; but after the granulations had been cured, the eyes were in such a satisfactory condition that I was enabled to make artificial pupils to both eyes, thereby restoring a little sight to the right eye, and also good sight to the left.

Fig. 17.



Right. Left.

Appearance of both eyes in March, 1881.

After an interval of five years the cure remains complete. There is a liability to relapse in this affection. A person who has been once troubled may suffer from a new attack from the slightest exciting cause; hence he must avoid occupation near the fire, crowded houses, smoking rooms, and such like places.

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[1] 'Brit. Med. Journ.,' 1875, and 'Med. Times and Gazette,' April, 1876.

DIPHTHERITIC CONJUNCTIVITIS

This disease is almost unknown in this country. During my practice in Scotland, extending over a period of about twenty years, I have met with only three or four cases of diphtheritic-looking patches upon the conjunctiva; they were mild cases, and yielded to treatment. Neither is the affection known in France. Desmarres and Sichel never mention it, and, what is very remarkable, Bretonneau and Trousseau, the classical writers on diphtheritis, and Rilliet and Barthez, make no mention of eye complication in that complaint. Even in the South of Germany the disease seems to be unknown. Arlt, of Vienna, mentions some sporadic cases, but they were of a mild type, and can hardly be classed as diphtheritic. In the North of Germany, however, and especially in Berlin, it sometimes prevails epidemically. Von Graefe, who had witnessed such epidemics in his Berlin clinique, has given us an interesting sketch of the disease,[1] and Hirschberg's article[2] is one of the most interesting contributions to the literature of the subject.

It must not be assumed, however, that this country enjoys perfect immunity, for Dr Samuelson reported occasional epidemics in Manchester,[3] and Dr Tweedy published some cases which occurred in his own practice.[4]

The disease is characterised by a firm fibrinous exudation into the parenchyma of the conjunctiva, accompanied by cell-proliferation, with a tendency to necrosis. In cutting down upon a patch at a post mortem, two days after the attack, Hirschberg found that even then the conjunctiva was rigid and yellowish serum exuded. In another post mortem, after an attack of seven days' standing, he found fatty degeneration of the cell element of the conjunctiva. It is distinguished by a greyish-yellow colour of the conjunctiva palpebrarum, and cul-de-sac; the eyeball is extremely sensitive to the touch, and there is copious discharge of hot scalding tears, with great swelling of the eyelids, especially the upper, which is distended, glistening, and hangs over the lower eyelid. The secretion from the conjunctiva is watery, of a dirty-greyish colour, and contains yellowish fragments. According to the depth of the tissue affected, it may either end in resolution or leave behind conjunctival and corneal cicatrices, or it may produce total destruction of the eyeball.

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[1] 'Archiv f. Ophthalmologie,' i, 1853.

[2] 'Graefe's Clinische Beitraege,' i, p. 3, 1871.

[3] 'Report of Intern. Ophthalmological Congress,' London, 1873.

[4] 'The Lancet,' January, 1880.

Treatment.—Von Graefe's treatment consists in the application of twenty or thirty leeches round the orbit and mercurial ointment. Hirschberg's treatment comprises a strong mercurial course and painting over the diphtheritic patch with collodion, to prevent it from spreading. Tweedy succeeded in curing unmistakable cases of diphtheritic conjunctivitis by washing the conjunctival sac every two hours with a solution of sulphate of quinine, gr. iij to the ℥j.

My own cases were so mild that I employed poultices, and poured Oleum c. Atropia upon the patch, applying mercury and belladonna ointment to the eyebrows and temples, and ordering good diet with large doses of quinine.

PTERYGIUM

Pterygium may be described as a sarcomatous, membranous, or fatty growth, affecting the ocular conjunctiva, the subconjunctival tissue, and the aponeurosis of the recti muscles. The different forms are known as—

(*a*) *Cellular*, when the subconjunctival tissue is thickened.
(*b*) *Vascular*, when the blood-vessels are developed.
(*c*) *Fleshy*, when the vascularity is more pronounced.
(*d*) *Fatty*, when the whole is transformed into a kind of fatty membrane.

In whatever form it appears it is always triangular, the base being at the caruncula, and the apex directed towards the cornea.

Pterygium generally affects only one eye, and occurs most frequently at the inner angle; but it is sometimes formed at the outer angle, and it may be present in both eyes. They may also occur double in the same eye when one is at the inner and the other at the outer angle, or both may be at the inner angle, one above the other. The occurrence of two pterygia is, however, rare.

The apex is sometimes irregular, and may even be bifurcated, while the base is either broad or narrow, according to the degree of development. It forms a winged-shape elevation, and contains a large number of sinuous vessels directed to the cornea. It is occasionally large, bright red from the number of blood-vessels, and very irritating to the eye, and may be complicated with conjunctivitis; in other cases it is flat and pale, and does not cause the slightest annoyance.

So long as it is confined to the ocular conjunctiva the base is not very broad, for this becomes large only when the pterygium advances to the cornea. The membranous form appears to consist of a thickening of the subconjunctival connective tissue and a morbid vascularisation of the aponeurotic expansion of one of the recti muscles. The vascular form is merely the membranous in a higher degree of development, while the fatty is composed of an accumulation under the vessels of white fibres of fatty appearance, forming dirty-yellow granules, which are scattered here and there within the membrane.

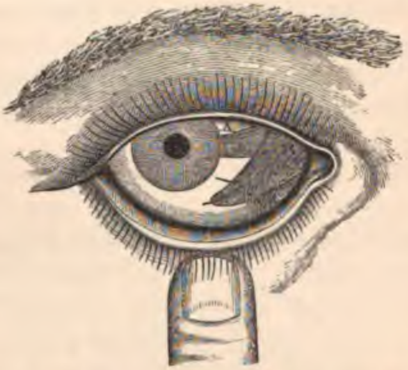
The progress of pterygium, especially when occurring in the membranous or fatty form, is very slow, in some cases remaining stationary for years. There is a patient under my observation at present (December, 1880), a captain of a steamer, who has had a pterygium, confined to the ocular conjunctiva of each eye at the inner angle, for upwards of ten years, without the slightest tendency to further progress. When, however, it occurs in the sarcomatous form it develops with great rapidity towards the cornea, and compromises vision, especially if the eye be exposed to irritating substances.

Prognosis.—When pterygium remains confined to the conjunctiva it is not very serious, but when it advances to the centre of the cornea vision is impeded. It is an unfavourable sign when the base is broad, and covers the upper and lower borders of the semilunar fold.

Causes.—This affection is generally considered to be the result of chronic inflammation of the ocular conjunctiva, but I cannot admit the accuracy of this view, having found that most of the patients who are thus affected have never had conjunctivitis. It is not common in this country, and occurs mostly in foreigners, or in persons who have been for a long time in warm countries. Furnacemen and blacksmiths are also liable to it.

Treatment.—All medical treatment, such as the application of Vin. Opii, Sol. Argent. Nitras, so much vaunted by the older writers generally, proves worse than useless, for the more the pterygium is irritated the more rapidly will it grow, and the higher will the vascularity become. So long as the affection is confined to the conjunctiva it is much better to let it alone, for it is only when it encroaches on the cornea and threatens to cover the pupil that an operation is required for its removal.

Fig. 18.



A, place where pterygium was situated; B, separated and deflected from its attachment; C, its new place of insertion.

Desmarres' operation, represented in Fig. 18, occupies the highest rank, and is performed as follows :—The eyelids being separated by a speculum, the pterygium is seized at a distance of several millimeters from the cornea, and raised with the forceps and dragged towards the base ; a cataract knife is then inserted beneath it, and it is first removed from the cornea, and then dissected to its base. Next an incision, four or five millimeters long, is made parallel to the circumference of the cornea, and the pterygium is introduced into this wound, where it is fixed in position by means of ligatures. It very soon atrophies, and when thus treated does not return, as it is liable to do after excision, or after any other course of treatment.

BURNS OF THE CONJUNCTIVA—SYMBLEPHARON

When the conjunctiva of the lid and of the eyeball have been burnt with hot metal, gunpowder, quicklime, or the like escharotic substances, Ol. c. Atropia is a valuable remedy[1]. Even when the burn extends over a large surface of the conjunctiva of the ball and the corresponding palpebral conjunctiva, if the superficial layer is implicated, the atropine oil is quite sufficient to keep the surfaces from adhering; but when the burn is of the third degree, involving the deep conjunctival layer, there result adhesions of the eyelid to the ball or cornea, with immobility of the eyeball, called *symblepharon*.

Numerous are the expedients which have been resorted to for the cure of this affection, but they have all for their object the mechanical separation of the lid and eyeball until the new surfaces cicatrise. Some surgeons endeavour to effect this by simply dissecting the adherent lid away from the eyeball, and then tearing the wound daily for a certain period, until it no longer unites; others, again, try to keep the surfaces separate by interposing foreign bodies, such as sealing-wax, glass shields, or similar substances. It is always found, however, that nature frustrates any attempt to remedy the deformity by such expedients, for they are based upon the supposition that a delicate physiological action can be replaced by a mechanical contrivance, whereas whenever such surfaces rub upon each other they ultimately adhere together.

For a number of years I practised an operation, which was first introduced by Mr Teale, for the radical cure of symblepharon, by taking a portion of the neighbouring healthy conjunctiva of the eyeball, wherever it can be got, and therewith replacing the palpebral conjunctiva which has been destroyed; for the loss of conjunctiva oculi is regenerated without prejudice to the neighbouring tissue, whilst loss of the conjunctiva of the lid is sure to damage the cornea by friction. My method differed from Mr. Teale's in that, while he dissected the conjunctiva oculi to the cul-de-sac, then twisted it round and stitched it to the conjunctiva of the lid, I, on the other hand, entirely removed it, and transferred it to the place where it was required. For it seemed to me that such twisted pedicles, instead of securing the maintenance of vitality, was rather a source of irritation.

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[1] ℞ Atropiæ, grs. ij;
Olei Ricini Recentis, ℥j. Misce.

Place in a warm bath until dissolved. Apply few drops to the burnt surfaces.

There is a limit, however, to the extent to which we may go in borrowing conjunctival substance from eyes which have been already injured; if we exceed that limit the corneal opacity may extend still further, and we lose the last chance of saving vision; and it is for such cases I devised the method of making up the deficiency by transplanting a portion of the conjunctiva from the rabbit.

The result of my first operation was submitted to the Glasgow Medico-Chirurgical Society in December, 1872, and the second in February, 1873. This method has since been practised by De Wecker, Otto Becker, Graefe, Cohn, and others. The principle, indeed, of transplanting mucous membranes has since been practised successfully in certain cases of obstetric surgery.[1]

Conjunctival transplantation is performed in the following manner:—I put the patient and two rabbits under chloroform, one being kept in reserve in case of accident. I then separate the adhesions, so that the eyeball can move in every direction. Next, I mark the boundary of the portion of the conjunctiva of the rabbit which I wish to transplant, by inserting four black silk ligatures, which I secure with a knot, leaving the needles attached; those black ligatures indicate also the epithelial surface, which would be very difficult to distinguish after separation. I take from the rabbit that portion of the conjunctiva which lines the inner angle covering the "membrana nictitans," and extending as far as the cornea, selecting this on account of its vascularity and looseness. The ligatures being put on the stretch, I separate the conjunctiva to be removed with scissors, and transfer it quickly to replace the lost conjunctiva palpebræ of the patient, securing it in its place by means of the same needles, and adding other two stitches, or more if requisite.

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[1] Beigel, 'Die Krankheiten des weiblichen Geschlechtes,' Stuttgart, 1875.

Both eyes are then covered with a bandage and dry lint. For the first forty-eight hours the conjunctiva has a greyish look, but it gradually loses that appearance, and, with the exception of some isolated patches here and there, becomes glistening, in some parts looking not unlike conjunctival thickening. These patches gradually decrease until the whole assumes a red appearance. Should any irritation set in I apply warm-water fomentations.

With regard to chloroform, Professor Cohn operates on the rabbit without anæsthetics, and I should myself prefer to do so if I could manage satisfactorily, for rabbits do not stand long anæsthesia; but the struggles of the animal are a very great obstacle in the way of the careful dissection required.

As to the patient, it must be borne in mind that, it is a long and tedious operation, taking about three quarters of an hour in its performance, and that under no circumstances is it safe to maintain insensibility throughout the whole process. In a grown-up, intelligent person, therefore, I do it without chloroform; and in the case of young patients I put them under chloroform only during the first stage, viz. when dissecting and separating the adhesions, and complete the rest by humouring the patient into submission.

Although I resorted at first to this method only in cases in which there was no disposable neighbouring conjunctiva of the burned eye to supply the deficiency, I found the result so highly satisfactory that under no circumstances would I think myself justified in removing healthy conjunctiva from an injured eye, but in all cases I supply the deficiency from the conjunctiva of the rabbit as being the safest and best method now at our disposal for the cure of such injuries.

The following two cases I exhibited to the Surgical Section of the British Medical Association in Edinburgh in August, 1875:

Fig. 19 represents the case of Peter C—, aged 25, quarryman, who received an injury in his face and eyes from a gunpowder explosion in January, 1872. When he first came to the Glasgow Ophthalmic Institution, four months after the accident, his face was riddled and discoloured by powder; both upper and lower eyelids of the right eye were considerably everted, and the left eye was completely closed and blinded by symblepharon. I made an irridectomy upwards which resulted in tolerably good sight when the upper eyelid was raised. On presenting himself in January, 1873, I remedied the symblepharon by transplantation from the rabbit. The examination of this eye will aid you in the appreciation of this

FIG. 19.

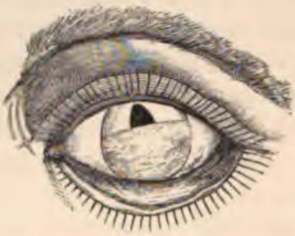
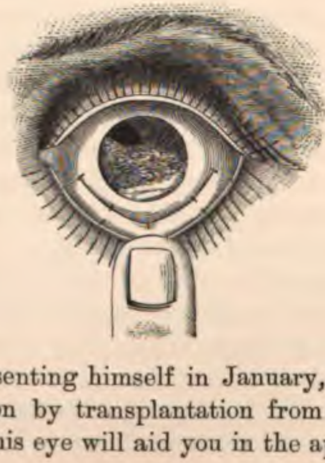


FIG. 20.



method. The extent of the corneal opacity shows the amount of the original injury which could not have been remedied by any known procedure.

Fig. 20 represents the case of Francis B—, aged 9, who had his right eye burned with lime in January, 1875, producing adhesion of the lower eyelid to the eyeball to the extent of covering the greater portion of the cornea; the cornea being thus rendered almost entirely opaque with the exception of the small upper segment, and there was no conjunctiva of the eyeball left available for supplying the deficiency. I therefore first turned the transparent portion of the cornea to account by making an artificial pupil upwards and inwards, whereby I restored a considerable amount of sight. Having procured this advantage, I operated ten days before exhibiting him to the Section for the cure of the symblepharon, by transplantation from the rabbit. You will see that some of the ligatures are still in the new conjunctiva from the rabbit, and on seizing the loose portion of the new membrane with the forceps, it will show you the vitality of the transplanted portion; you will notice, also, that the same membrane has some greyish points here and there, while the rest of its surface has assumed a shining pinkish appearance. The mobility of the eyeball and the action of the eyelids are also restored. The main difficulty in the operation, which must have caused some failures, is to keep the anterior surface of the flap forward; it has a tendency to roll up so that the surfaces cannot be distinguished; the black threads obviate this difficulty to some extent only. When therefore the immediate transference is impracticable, it is best to spread the conjunctiva upon the dorsum of the hand where it soon dries, and it can be raised with a silver spatula and placed in its new position. If it sticks to the hand firmly a drop of tepid water causes it to loosen its hold.

ANCHYLOBLEPHARON

When there is adhesion of the borders of the eyelids to each other, it is called *anchyloblepharon*. This adhesion may be either partial or extend through the whole margin. It may be confined to the edges of the lids, or be complicated with symblepharon.

Cause.—It sometimes occurs congenitally, but generally is caused by burns.

When anchyloblepharon is partial we can, by introducing a probe, easily ascertain the condition of the conjunctival sac; but when it is complete, we endeavour to ascertain whether symblepharon is also present. This can be determined by pinching up a fold of the upper eyelid and drawing it away from the eyeball, then ordering the patient to make an effort to turn his eye in every direction, we can thus see to what extent there is free movement, or whether the ball is fixed. If the eyeball is completely adherent, an attempt to remedy it by operative interference would be useless; but when the symblepharon is partial, we give the patient a chance of recovering his sight by an operation.

Operation.—Simple *anchyloblepharon* is easily remedied. When there is a small opening left between the edges of the eyelids, I introduce one blade of the scissors through it, and then separate the whole extent of the adhesions. When no opening is left between the lids, I pinch up a vertical fold of the eyelid, into which I make a section with the scissors in the middle in a line where the separation ought to be, and then separate the adherent lids in both directions. The lids, when once separated, never adhere again. When symblepharon co-exists, we are then, after the separation of the lids, in a position to judge whether the case is remediable or not. If there be symblepharon in one eyelid, conjunctival transplantation is indicated; but if it extends to both eyelids, there is little encouragement to improve the condition of the eye by an operation.

SPONTANEOUS HEMORRHAGE OF THE CONJUNCTIVA

This may be caused by a violent fit of coughing, vomiting, or straining, which causes rupture of the conjunctival blood-vessels, and so permits effusion of blood into the substance of that membrane, but it may also occur without any known cause. This infiltration resembles hæmatoma in some cases; but, although the patient may be much alarmed at its appearance, it is of trivial significance, and requires no special treatment. It is best to keep the eye bandaged, and apply slightly astringent collyria, or warm water fomentations, under the influence of which the discoloration will very soon disappear.

TUMOURS OF THE CONJUNCTIVA

Are:—1. *Pinguicula.*—This is a small yellowish tumour, situated in the subconjunctival tissue upon the horizontal meridian of the eye, in the course of the external or internal rectus muscle. The analysis of M. Robin shows it to be an epithelial tumour, not fatty as was formerly supposed. The number, therefore, of supposed lipomas (fatty tumours) of the conjunctiva has been reduced, and, indeed, they are of rare occurrence, although v. Graefe and Otto Becker have reported some cases. At present (June, 1880) there is a young man, aged 25, visiting the Ophthalmic Institution, who has a large pinguicula situated midway between the semilunar fold and the cornea. When it grows rapidly and begins to annoy him, we shall remove it—opening the conjunctiva with scissors, snipping the tumour off, and bringing the edges of the wound together with a silk ligature.

2. *Polypus.*—Which is a pale vascular tumour with a pedicle, generally situated at the plica or caruncula; it is superficial and easily removed by the scissors. You must take care to remove the whole thickness of the conjunctiva and apply astringents to the cut surface in order to prevent a relapse.

3. *Epithelioma and cancer,* either medullary, fungoid, or melanotic may attack the conjunctiva. *Epithelioma and melanosis,* when confined to the conjunctiva, may safely be got rid of, without fear of relapse; but, when the cornea is involved, and the disease is of a more malignant type, removal of the eyeball without delay becomes necessary. Indeed, malignant cancer generally attacks the conjunctiva after the deep tissues are affected.

LECTURE V

SCLEROTIC AND CORNEA

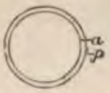
Gentlemen,—The external coat of the eyeball consists of two parts, viz. the sclerotic, which is opaque, and the cornea, which is transparent. The sclerotic is formed by a dense, irregular interlacement of fibrous tissue, the surface being white, and the glistening appearance of "the white of the eye" is owing to the sclerotic covered by the conjunctiva. The sclerotic is thickest at the posterior surface of the globe, for the support of the retina, and for the preservation of its curvature. Around the foramen, at the entrance of the optic nerve, it is about $\frac{1}{25}$th of an inch thick, and from this locality it gradually becomes thinner forwards as far as $\frac{1}{4}$th of an inch from its junction with the cornea, where it is only $\frac{1}{40}$th of an inch, from which line it again increases to about $\frac{1}{35}$th of an inch in thickness.

At the entrance of the optic nerve into the sclerotic the cellular tissue which envelopes the nerve becomes united to the sclerotic. When the fibres of the nerve are removed by maceration we obtain a thin layer, pierced with many holes, which is continuous with the internal surface of the sclerotic. This is called the cribriform lamina of the sclerotic; the smaller perforations give passage to the bundles of the optic-nerve fibres; in the middle there are two larger perforations, through which pass the artery and vein of the retina.

The cornea is nearly circular in shape, occasionally wider from side to side than from above downwards, and its anterior surface is generally less extensive than the posterior, sometimes considerably so (Fig. 21). The edge by which it is continuous with the sclerotic is bevelled, so that the latter overlaps it.

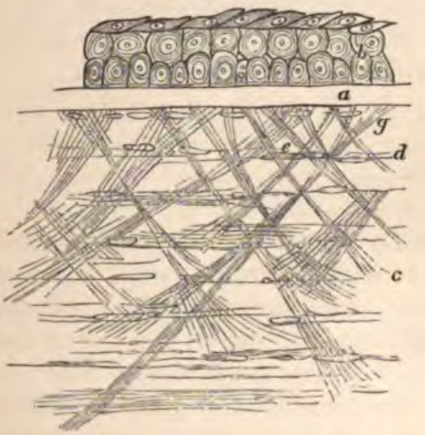
The cornea consists of the following layers from before backwards, viz. epithelium, anterior elastic layer (Bowman), cornea proper, Descemet's membrane, and epithelium of the aqueous chamber. These layers do not lie loosely upon one another, for there exists direct communication between them.

FIG. 21.



a, anterior surface; *p*, posterior surface.

FIG. 22.



Vertical section of the human cornea near the surface. *a*, anterior elastic lamina; *b*, conjunctival epithelium; *c*, lamellated tissue; *d*, intervals between the lamellæ, showing the position of the corneal tubes collapsed; *e*, one of the nuclei of the lamellated tissue; *g*, fibrous cordage sent down from the anterior elastic lamina. Magnified 300 diameters. (Bowman.)

The sclerotic and cornea are sparingly supplied with materials of nutrition. The sclerotic is obliquely pierced posteriorly by numerous arteries (posterior ciliary) derived from the ophthalmic, but these go almost exclusively to the choroid, only giving a few minute twigs to the sclerotic as they pass through. In front, too, the arteries which have supplied the muscles of the eyeball send forward beyond the tendons small prolongations, which are visible under the conjunctiva, and lose themselves in the sclerotic within $\frac{1}{8}$th of an inch from the margin of the cornea. These, however, traverse rather than supply the sclerotic, and anastomose with the vessels of the ciliary muscle and iris. Hence, in the most successful injections, the sclerotic itself is with difficulty tinted by the artificial colour, and when we pass from the sclerotic to the cornea we find that no blood-vessels at all encroach far beyond its border. There is, therefore, a considerable difference between the sclerotic and cornea, the one being permeated with blood-vessels, while the other is entirely devoid of them.

Nervous supply.—The sclerotic gives passage to the ciliary nerves, from which it receives filaments; but in a state of health it seems to be very insensible, whereas the cornea possesses numerous ramifications of nerves.

DISEASES OF THE CORNEA

In studying diseases of the eye, your interest is apt to be absorbed in the tissues exhibited by the ophthalmoscope. To see the end of the optic nerve and its blood-vessels, to see the retina, upon which brain, heart, kidney, and arterial diseases are registered, is an interesting sight. The cornea, which is within the reach of the naked eye, you are disposed to consider as commonplace, yet it is a structure worthy of your great attention, for, after all, what is the use of these structures—retina, nerve, refracting apparatus—when the cornea is opaque? To attend to the different phases of its morbid condition, to notice the way in which nature repairs the corneal lesions, is interesting, not only on account of its essential importance to the visual organ, but also on account of the light which it sheds upon the vital processes of other parts of the organism.

The principle which I have laid down with regard to the study of the conjunctiva, viz. to associate the different forms of inflammation with the depth of the tissue affected, is even more applicable to the cornea, because its transparency enables us to gauge accurately its morbid anatomy, to note the different layers affected, and the phases through which they pass. Besides, the cornea is not a common membrane, but a peculiarly organised structure. Being devoid of blood-vessels, it has to draw its nutriment from the adjacent tissues, and in pathology we are actually able to see the process by which this is achieved.

Pannus or Superficial Vascular Corneitis

When the corneal epithelium is slightly irritated, or affected in any way, a stimulus is communicated to the periphery where new blood-vessels are formed. Plexuses of these vessels proceed to the part of the cornea affected, giving the appearance of a fine scarlet covering, and this is called *pannus tenuis*. Of this form of pannus we have an instance, on a limited scale, in phlyctenular affections. The vessels are nutrient and restitutional, developed for the repair of the tissues. If, instead of being confined, as in *phlyctène*, to limited spots, it covers the whole, or nearly the whole, of the cornea, we call it "panniform corneitis." In trachoma, when the palpebral conjunctiva is covered with granules, or there is fatty degeneration of that tissue, causing friction upon the cornea, a membrane is formed consisting of coarse, dusky vessels (pannus crassus). These vessels are protective, being formed to guard the epithelium from the friction of the rough surface of the lid.

Treatment.—This comes within the category of pustular conjunctivitis and trachomatous pannus.

Corneitis—Keratitis

The examination of the different layers of the cornea is best conducted in clear sunlight. Look at it first with the naked eye in an oblique direction, then apply the biconvex lens of your ophthalmoscope, through which you send a pencil of rays either of natural or of artificial light upon the affected part. For the examination of the deeper layers, the light admitted obliquely through a slit in the shutter and a duplex lens give more satisfactory results. The best means, however, for the exploration of the deep structure is the ophthalmo-microscope of Donders. With it you may see the finest blood-vessels stretching from the periphery, apparently in a state of collapse, but which must have been formerly the carriers of materials of repair to the diseased part. Indeed, the use of focal illumination and the ophthalmo-microscope should, in doubtful cases, never be neglected.[1]

The inflammation of the cornea may be either—(1) superficial or (2) parenchymatous.

Superficial corneitis is a circumscribed opacity of a greyish colour, from which the epithelium is thrown off, the cornea presenting an inequality of surface, which is best seen by focal illumination. When the inflammation gains in depth the opacity becomes of a yellowish hue. It may be situated at the periphery or at the centre. The conjunctiva is injected, and a net-work of blood-vessels forms round the cornea, either upon the conjunctiva or in the subconjunctival tissues, according to the depth of the corneal layer affected.

General symptoms.—There is photophobia or blepharospasm, lachrymation and ciliary pain, *i.e.* pain shooting to the temple, eyebrows, gums, and in the whole course of the fifth nerve, and there is also, as you may expect, contraction or sluggishness of the pupil. It is accompanied by another symptom, viz. sneezing, when the lid is raised.

Let me explain to you the significance of these symptoms. Photophobia—fear of light. We have seen (p. 13) that the iris regulates the quantity of light to be admitted to the retina. An impression is conveyed to the brain by the optic nerve and then reflected through the "motor oculi" and "ophthalmic ganglion" to the iris, and the pupil contracts; in darkness the pupil dilates, the amount of contraction being regulated by the quantity of light admitted. At every contraction there is a dragging sensation communicated to the branches of the same nerve which supply the cornea, and hence there is a shrinking from light. Children who are troubled with this form of keratitis, put their faces upon a pillow or upon their hands, and when one eye is affected they twist their heads to the unaffected side.

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[1] The instrument of Donders is intended primarily for measuring the depth of the anterior chamber; its size and costliness, however, prevent its being commonly adopted. A new duplex lens convenient for general use has recently been invented by Hirschberg for the study of the layers of the cornea.

Photophobia used formerly to be considered as symptomatic of retinal affection, but that this view rested upon an erroneous conception is evident, because the ophthalmoscope shows an absence of retinal injection, and it is generally caused by some injury to the external tunic without internal complications. Hence, v. Graefe proposed to abandon the term photophobia and to adopt blepharo-spasm in its stead; but as photophobia is the current phrase, and is very expressive, there is no use changing it, if you only associate it with its proper cause.

Sneezing is another symptom. The cornea being denuded of its epithelium and laid bare, when the lid is raised, atmospheric air, acting as an irritant upon the nerves, which ramify in the lamellated cornea, induces a reflex irritation of the nasal branch of the fifth, which supplies the Schneiderian membrane, causing sneezing. After some experience you will be able to judge by this symptom, by the manner in which the patient carries his head, and by the facial expression, what part of the cornea is affected and the intensity of the disease, even before inspecting it.

Prognosis.—When superficial it may, under treatment, disappear in a fortnight without leaving any trace; but when deep-seated, and especially when engrafted on a scrofulous cachexia, it may end in partial opacity, although generally it has a favorable issue.

As one of the causes of keratitis may be mentioned carious teeth.

Treatment.—Warm fomentations and solution of atropine are required, and blisters should be applied to the temples. The eye should be bandaged; good nourishment ordered, and change of air recommended. All decayed stumps of teeth must be extracted.

DIFFUSED OR PARENCHYMATOUS CORNEITIS

This form is not confined to one spot, but extends through the whole cornea without inflammatory symptoms of the limbus.

The opacity is uniform, and so thick that the iris appears as if changed in colour, because it is seen through an opaque cornea. It may attack the whole tissue at once, or it may start from the periphery and rapidly spread to the centre.

The pathological changes of this form of keratitis are, according to Virchow, "essentially seated in the corpuscles or cells of the cornea." These cells become swollen and opaque until they present the appearance of sacculated canals or tubes. While this enlargement of the elements (this acute hypertrophy) is going on, the contents of the cells are, at the same time, becoming more cloudy, and it is this cloudiness of the contents which, in its turn, occasions the opacity of the whole coat, for the proper basis substance appears to be altogether unaffected. This cloudiness of the contents is in part occasioned by particles which are of fatty nature, so that the process seems to have begun to assume the character of a degenerative disease; but that condition is not at variance with the possibility of restoration, for since the cells still exist the only thing required is that their changed contents be got rid of; for in a given case, where nothing has taken place except that the cells, without ceasing to display their activity, have accumulated in their cavities a larger quantity of material than usual, everything is prepared for the process of reabsorption; the cells can transform a certain quantity of material, and convert it into soluble substances, and the material in this form may disappear in the same way as it came. The structure, in the main, remains the same all the while; nothing foreign has thrust itself between the parts; the tissue presents throughout its original constituents.[1]

But when the process of repair sets in there is a reaction at the limbus, and we begin to notice straight vessels, set close to each other, giving the appearance of extravasated blood. This is the sign of commencing resolution. In my opinion Virchow's theory of cell pathology is strictly applicable to the first stage of the disease, when the characteristic changes consist essentially in an alteration in the cellular element of the tissue, the primary irritation being caused by the central part, which has no blood-vessels; but at a subsequent stage the new-formed vessels at the periphery assist in the various phases of elimination of the morbid material. I venture to suggest this as a compromise between Virchow's doctrine and the old principle, "*ubi stimulus ibi affluxus.*" Indeed, it would be difficult to explain morbid processes upon a theory which restricts itself to vascular, neural, or cellular pathology.

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[1] 'Cellular Pathology,' p. 306.

Causes.—Debility, bad nourishment, and scrofulous cachexia, are the most frequent causes of the disease in question. When connected with syphilitic taint it is marked by notched (Hutchinson's) teeth.

We must not overlook another cause of keratitis, namely, uterine irritation. The reflex pathological condition of the uterus upon the ocular apparatus, giving rise to functional derangement, or to organic changes in the latter, is well known. Women at the age of twenty or thirty, who are irregular in their monthly discharges, sometimes complain of a dragging sensation at the back of the eyes, which may become very distressing. During pregnancy females are subject to various forms of retinal affections, serous effusion, or retinal hæmorrhage. Protracted lactation sometimes produces acute optic neuritis or atrophy of the optic nerve. But in the case of girls who have just emerged into womanhood, whose constitutions or manners of living are unfavorable for encountering the strain of this development, the cornea is the most likely part to suffer. It assumes the form of corneitis we are now considering, and if not arrested may extend to the ciliary circle, and produce an obstinate form of cyclitis.

Corneitis may sometimes be caused by injury. In traumatic cases, however, the parenchymatous affection is of a somewhat mixed character, having the appearance of punctative and suppurative keratitis, as in the following case, which I have reported:[1]

Jane L—, æt. 17, had her eye injured by a beard of barley in November, 1879. She was brought to me on November 25th with multiple abscesses of the cornea, giving it somewhat the appearance of punctative keratitis. The whole cornea was

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[1] 'Brit. Med. Journal,' Feb., 1880.

opaque and the iris invisible; but the worst feature was the absence of any cyclitis or reaction in the neighbouring parts; the inflammation seemed to be *asthenic* in its character. Pus exuded, as it were, from interrupted points throughout the whole substance; and it was the occurrence of these interrupted points which enabled me to pronounce the case not altogether hopeless. There was constriction at the ciliary border, and as I had a suspicion that there might be some pus in the aqueous chamber, I determined to make a limited sclerotomy, and introduced a narrow lance to evacuate the aqueous humour, but very little issued. The course of treatment upon which I then determined was the direct application of hot steam to the eyeball, and under this it began to recover. The first appearance of improvement was the formation of blood-vessels proceeding from the periphery to the cornea proper, first at the inner segment, and then extending over the whole of the corneal circumference. After two months' daily use of the vapour the cornea cleared up, vision became nearly normal, and only by focal illumination could the deep cicatrices of the cornea be seen, showing the narrow escape the eye had.[1]

Treatment.—From the remarks just made on the causation you will see that we have not to deal with a local affection, but with one of extensive ramification. In every case of keratitis you must consider not only the patient's own life and habit, the atmosphere he is breathing and the food he is getting, but also from what stock he has come—whether he has inherited struma, or the dregs of syphilis, or a mixture of both. What renders its clinical study the more interesting is, that you may get this information almost without interrogating the patient, as in veterinary surgery you can have it from the appearances, complexions, teeth, glands, and cornea itself. You must, therefore, combine local with constitutional treatment, and, as a local application, atropine is our sheet-anchor, warm fomentations and blisters at the temple and round the brow being also employed. In cases like the one above recorded we derive more benefit from the application of steam than from all other remedies. If connected with struma, Syrup. Iod. Ferri et Quinia is to be administered. Warm fomentations and solution of atropine are required, while blisters may be applied to the temples. The eyes should be bandaged, good nourishment ordered, and change of air recommended. All decayed stumps of teeth must be extracted. In cases of syphilitic taint I order mercurial ointment to the armpits and iodide of potassium internally, and the grey ointment is applied to the eyebrows and temples.[1] When there is constriction at the limbus, and the cornea is threatened with permanent damage, a paracentesis of the cornea at its extreme scleral border or sclerotomy is absolutely necessary. These have sometimes a charming effect, and can never do any harm in such cases.

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[1] A very convenient instrument for the purpose is made by Collins, Rue de l'Ecole de Médecine, Paris.

Change of air is of great help after the corneal transparency has been restored, but so long as there is danger the case must be watched. Many a poor patient has been sent for change of air who has come back with the cornea permanently destroyed.

Abscesses of the Cornea—Onyx

When an abscess of the cornea does not involve the Descemet membrane it is called onyx, but when it involves the whole thickness of the cornea, and the pus penetrates the aqueous chamber, there is onyx and hypopion (pus in the eye). The pus gravitates to the lowest part of the anterior chamber.

Onyx may be either *sthenic*, when it is accompanied with intense ciliary pain and injection of the limbus conjunctivæ, or *asthenic*—indolent—when it steals on insidiously, without marked reaction. The dangers arising from this affection are very great:

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[1] ℞ Hydrargyri Ammonio-Chloridi, ℈j;
Extracti Belladonnæ, ʒij;
Unguenti Simplicis, ʒiij. Misce.
Fiat Unguentum. Apply to the eyebrows and temples.

1. You cannot expect the cornea, the seat of an abscess, to resume its transparency; there will at least remain more or less opacity, according to the thickness of the layers involved.

2. The pus may be absorbed, and leave behind broken-down corneal tissues as deep ulcers, which may become troublesome.

3. The inflammation generally extends to the iris, which becomes adherent to the cornea (synechia anterior).

The indolent abscess attacks cachectic, ill-nourished children, and is also a concomitant of cerebral affections, tubercular tumours in the brain, diabetes, or neuro-paralysis (*i. e.* paralysis of the fifth nerve). Claude Bernard has demonstrated that, after dividing the fifth nerve in animals, abscess of the cornea results. At a recent meeting, however, of the Académie de Médecine, M. Laborde showed a rabbit in which he had succeeded in dividing the ophthalmic branch of the fifth alone, making the section through the temporal fossa, and in limiting the injury, the result was purulent infiltration of the anterior chamber without changes in the cornea. He therefore argues that Bernard's method of dividing the nerve involved other lesions besides the fifth nerve, and hence produced corneal infiltration. But, as in cases of tumour of the brain or of Gasser's ganglion, which interferes with the nutrition of all the tissues, the lesion can never remain limited, but must eventually extend to all the tissues, corneal abscess is the natural result.

The neuro-paralytic form is characterised by a complete absence of reaction; the conjunctiva is pale and insensible to irritation from dust or air, or to the touch. Corneal abscess may also be a sequela of typhoid or scarlet fever, and we have now a case under treatment (January, 1881) of a boy, aged 10, in whom it followed measles. It may also be the result of injury, especially if inflicted with coal, contact with which is very dangerous to the cornea, from which the inflammatory action generally extends to the iris and the deep structures.

Treatment.—Warm fomentations should, if possible, be applied constantly during the day, and at night the eyelids should be painted over with Ext. Belladonnæ.

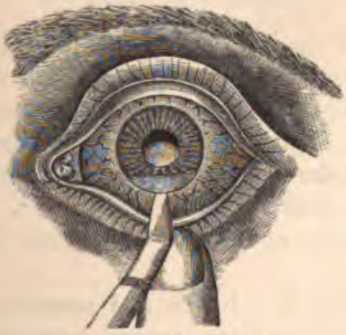
When the abscess threatens to involve the deep layer a paracentesis is necessary, in order to relieve the internal pressure. If the pus be fluid the puncture should be made in the lower border of the abscess, so that the aqueous humour may favour its evacuation; but if tenacious the paracentesis should be made in the corneal border in the healthy cornea.

HYPOPION

When pus has entered the anterior chamber it must be emptied. I generally wait until the suppurative process is nearly exhausted, and then open the cornea and let the pus out, repeating the operation two or three times if necessary. I do not allow it, however, to accumulate too much—not beyond the fifth part of the anterior chamber.

Operation.—The patient is reclined upon a couch, a speculum is introduced, the eyeball is fixed with forceps in its horizontal meridian, a narrow lance is introduced at the lower border of the cornea-scleral junction (Fig. 23); and in withdrawing the instrument gentle pressure is made at the lower lip of the wound. When the pus is fluid it will follow the lance, but if it be stringy, part of it will come away, while the remainder will stick in the wound, where it must be laid hold of with small iris forceps, and then withdrawn. If a string of pus adheres to the iris I introduce a flat silver probe,

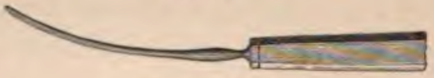
FIG. 23.



Onyx and hypopion.

bent to a suitable angle, and, gently detaching it from the iris, withdraw it with forceps.

FIG. 24.



General treatment.—Mild aperients and tonics are helpful, and also rest to the eyes. Both eyes should be firmly bandaged, when warm fomentations are not on, to favour absorption. There will always remain an opacity of the cornea, but this must not be touched till some months after the disappearance of the abscess, when calomel powder may be applied with the view of reducing it. On no account should you put ointment of any kind upon an abscess, or upon an ulcerated cornea, a practice which has recently been recommended to kill bacteria, lest you kill the cornea along with the hypothetical organisms.

ULCERATIVE KERATITIS

In this disease we have softening and elimination of the corneal substance, which may assume either the *sthenic* or the *asthenic* form. The *sthenic* form is accompanied with ciliary pain, photophobia, lachrymation, and pericorneal inflammation; focal illumination showing the disappearance of the epithelium. The border of the ulcer is greyish and swollen. In the asthenic ulcer there is little or no ciliary pain, neither photophobia nor lachrymation.

Causes.—Debilitated subjects and scrofulous children are liable to it. Injuries of the cornea, however slight, may in some cachectic subjects generate an ulcer. Conjunctivitis, acute or chronic, when deep, may also, by interfering with the nutrition of the cornea, induce ulceration.

Prognosis is more favorable in acute than in the chronic form, and the former may entirely disappear. In the indolent form there is a risk of a white cicatrix (leucoma) remaining, or a fistula, and the iris may adhere to the cicatrix (leucoma adherans).

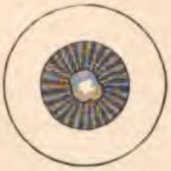
Treatment.—Locally apply atropine, and use calomel insufflation, employing warm fomentations, and a compress with bandages in addition. The less you open the eye the better, and all cauterisations and teasing of the cornea with washes are, I think, prejudicial, and ought to be avoided. In the asthenic type I use steam cautiously, with the view of producing reaction; and, indeed, I consider this agent worth all the other remedies combined. When a fistula has formed which proves obstinate, an iridectomy should be performed. I have seen a fistula of twelve years' standing, which used to be a source of great annoyance to the patient, bursting periodically, and upon which iridectomy acted like a charm. The operation should be done, whether there be a hernia iridis or not; but when there is a prolapse I never interfere with it, but make an artificial pupil in a line opposite to it (see Artificial pupil).

LECTURE VI

VASCULAR OPACITIES OF THE CORNEA

GENTLEMEN.—About fourteen years ago I had under treatment a case of a peculiar affection of the cornea, which has not been mentioned by systematic writers. It presented the following features :—In the centre of the cornea there was a white patch, which had been there for some years, but the rest of the cornea was quite transparent; there was slight injection of the ciliary circle, but no blood-vessels proceeded to the patch, which formed an island like any other *leucoma centralis*. The patch (Fig. 25) was of a dead-white colour, its centre, however, glistening slightly, like mother-of-pearl. It was of idiopathic origin, and I regarded it at first as an encrustation of lead from the lotion which had been used by the patient; but, in trying to shave off the white layer, I came upon a bleeding surface, from which blood issued freely. This phenomenon was a source of considerable surprise to me, inasmuch as it seemed to militate against the received views of the histology of the cornea.

FIG. 25.



Since that case came under my observation I have met with a considerable number of similar cases, some of which had a traumatic history, while others were of idiopathic origin, but all were of some years' standing. Only last year, indeed, we had two such cases in our clinique.

Mr. Bowman[1] says: "I have several times been struck with what you describe," and he explains it in the following manner:—"The blood flows from vessels coming from the margin of the cornea, which were formed when the cicatrix was forming, and have never since been obliterated, though collapsed and shrivelled. When the operation reddens the eye the vessels admit blood more freely, and when divided bleed." Professor Hirschberg also informs me that he has seen such cases with and without adherent iris. Only this summer (1880) he has seen a very interesting case of the kind in Arlt's clinique, at Vienna, in an Austrian sailor, just returned from the East. In this case there were patches on both corneæ, but no irritation. In one eye the iris was adherent, the greater part of the patch being covered with a blood spot, which lay behind the epithelium, and in every case he was able, by the aid of Donders' ophthalmo-microscope, to discover vessels coming either from the iris or from the periphery. In fact, he found arteries and veins in the collapsed condition just described in Mr. Bowman's letter. The duplex or Donders' instrument, then, reveals to us the source of that concealed blood in the vascular opacities of the cornea.

OPACITIES OF THE CORNEA

Causes.—Diseases of the cornea, such as abscesses, ulcers, lead deposits in its substance following the use of certain eyewashes, all produce permanent opaque spots upon it. They are really corneal cicatrices, and are easily distinguished from circumscribed opaque spots by the absence of all signs of perikeratic inflammation.

Varieties.—Opacities of the cornea may be brought under three different heads, according to the extent of the cornea involved from without inwards:—1. *Nebula.* 2. Albugo. 3. Leucoma.

A corneal opacity is called *nebula* when the epithelium and superficial layer alone are involved, forming a thin cloud, which is best seen by looking at it sideways. It is termed *albugo* when the anterior elastic layer, and *leucoma* when the deeper layers are affected and the opacity is white. When the iris is adherent to the white spot it is termed "*leucoma adherens*" or "*anterior synechia*," in contra-distinction to posterior synechia—a term used to designate those cases in which the iris is adherent to the lens capsule.

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[1] In a letter to the author.

Prognosis.—When the opacity is thin, and especially when such is the case in young subjects, it is certain to disappear under appropriate treatment. It is surprising to what extent these opacities do disappear.

Treatment.—In recent opacities I use calomel powder, a thin layer of which is dusted upon the opaque spot by means of a hair pencil, and friction is immediately afterwards employed by rubbing upon the cornea with the upper eyelid. When the case is of long standing I apply the Unguentum Flava, either simple or c. Atropia.[1]

It is necessary to remove the lead, quicklime, or other incrustation from the cornea, or shave off the part when incorporated with the tissue. If the opacity be central and large, an artificial pupil must be formed.

FOREIGN BODIES IN THE CORNEA.

These may be lodged in the epithelium, in the anterior elastic layer, or in the cornea proper, looking into the anterior chamber. When in the epithelium the foreign body is easily removed by means of a needle with a concave surface. When it has penetrated into the cornea proper, the eye should be fixed with speculum and forceps, the point of the needle entered by the side of the foreign body, and by using the instrument as a wedge it can be removed. The needle (Fig. 26) formerly used for couching is most suitable for this purpose. When the body has penetrated still deeper into the cornea, so as to look into the anterior chamber, and presents little surface to lay hold of, I follow Desmarres' advice, and introduce a lance into the anterior chamber to support the foreign body from behind, and then, enlarging the passage of entrance, push the body forward. v. Graefe's toothed forceps (Fig. 27) is the best instrument for the prehension of foreign bodies, and an oculist's case should never be without one, for by means of it we can seize and remove foreign bodies from positions in which, with any other forceps, they would be apt to slip out of sight.

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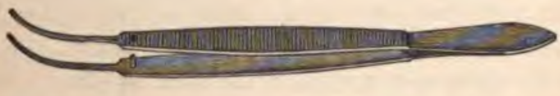
[1] See recipe, page 45.

FIG. 26.

Needle for foreign bodies and spoon adapted for pocket.

FIG. 27.



CONICAL CORNEA—KERATOCONUS

Keratoconus is a change in the normal curvature of the cornea, which becomes pointed, the cone being situated generally in the centre of the cornea but sometimes nearer its margin. When viewed from the front, it has the appearance of a shining piece of glass; and, when seen in profile, the elevation is well marked. The cornea becomes thinned and stretched at the prominent point, and in one case, examined by Hulke,[1] the distentions were found to be at the expense of the anterior elastic layer, which was thinned to one third of its marginal thickness, while the second layer was unchanged. Both eyes are generally affected, the conicity of the one being more marked than that of the other.

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[1] 'Ophthalmic Hospital Report,' part ii, p. 155.

We have at present under treatment a girl who came to the institution, November 13th, 1880, with one conical cornea and a brown coloured spot upon the corresponding part of the lens-capsule, the result of iritis. The distension generally begins at from fifteen to thirty years of age, progresses up to a certain point, and then remains stationary, even in its worst form, never causing rupture or ulceration of the cornea, and the tension of the eyes remains normal.

When the cone is perfectly developed you cannot mistake it; but at an early stage of its formation you will not be able to discover it with the naked eye. Your attention is at first called to the case by the subjective symptoms. The patient complains of near-sightedness—myopia; but even when he takes a book near his eyes, he finds the letters indistinct and confused—there is, therefore, myopia complicated with amblyopia, and the reason is obvious. The distension of the cornea lengthens the axis of the eye, and hence it becomes myopic, whilst at the same time the irregularity of the curvature produces a state of an exaggerated irregular astigmatism, causing confused vision.

At the incipient stage ophthalmoscopic examination will show you the cause of this state of things. If you throw light upon the cornea by the concave mirror, held at some distance from the cornea, you will see a bright-red reflection of the fundus in the centre, showing you the inverted image of the retina as in every myopic eye; this bright centre is surrounded by a dark zone, which is again surrounded by a bright ring representing the normal appearance of the retina as seen through the normal curvature of the cornea. The dark zone is the point of transition between the two luminous circles.

Treatment.—The only treatment applicable to the first stage of the central distention, is rest to the eye with abstinence from all work, which requires the examination of minute objects, and attention to the general health. When the cones have already formed, if of a moderate degree, and if vision is not embarrassed to such an extent as to unfit the patient for his ordinary occupation, I recommend non-interference. In extreme cases, in which distinct vision is much interfered with, v. Graefe rendered the cone opaque by the following method:—He introduced a small knife to the depth of the middle layer, and brought its point out at a distance of from 1 to 2 mm. The flap thus formed was seized with fine tooth forceps, and cut off close to its base with scissors. The raw surface was cauterised two days later with mitigated nitrate, and this was applied at intervals till a scar was produced, and the abnormal curvature thereby diminished. It takes two or three months to produce the desired effect.

Mr Bowman improved upon v. Graefe's method by removing a central piece of the cornea by means of a trephine. This instrument is applied to the cone until it nearly reaches Descemet's membrane, when it is withdrawn; the piece is then seized with fine forceps and dissected off with a broad needle. The thin layer thus left immediately bulges like a hernia, and it is then either punctured at its centre or a small central portion of it is excised—the object being to allow temporary drainage of the aqueous and thus promote the contraction of the cornea without the risk of anterior adhesions, for the small orifice made ought to correspond with the centre of the pupil; and to ensure accuracy in this respect he applies Calabar bean immediately before the operation, so that the site of the contracted pupil may be a guide to the surgeon.

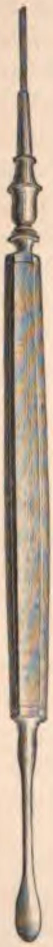
My own plan is to tint over the cone and thus produce an opacity of the distended portion. I then make a small artificial pupil so as to allow the rays of light to enter through the part of the cornea of normal curvature.

TINTING OF THE CORNEA

The practice of blackening white patches (leucomata) of the cornea, for the sake of improving the appearance of the eye, was current among the ancient Greeks, but it had fallen into disuse until 1869, when it was revived by de Wecker, upon the suggestion of his assistant, M. Abadi. Since then the operation has been acknowledged as an addition to ophthalmic surgery, and it is not only a safe method of covering deformities of the eye, but in some cases of keratoconus, when it is considered unsafe to remove the superficial layer of the cornea, it will be found to be advantageous to simply tattoo the cornea, and save thereby a painful operation.

Of all the instruments in use for the purpose that of de Wecker is the most useful, and consists of a needle-holder and a spatula (Fig. 28). The eyelids being separated by a speculum, a thick solution of Indian ink is smeared over the white spot with the spatula, and the part is then pricked, in an oblique direction between the layers of the cornea, with the needles. The eyeball is steadied with the fingers, and must not be touched with the forceps, or else the conjunctiva may become discoloured. The operation may be accomplished in one sitting; but if the cornea or the neighbouring tissues are liable to inflammation it may be done in two or three instalments.

FIG. 28.

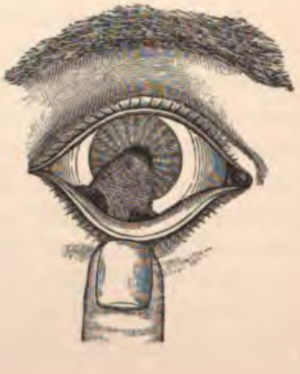


TUMOURS OF THE CORNEA

MELANOTIC SARCOMA

Tumours are rarely found in the corneal substance. They generally start from the cellular tissue of the limbus; indeed, there is no authenticated case on record of epithelioma or cancer of the cornea. Here is a case which came to the institution in July, 1880, represented in Fig. 29.

FIG. 29.



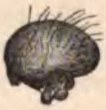
William M'M—, æt. 65, slater, blue irides presented himself on May 5th, 1880, complaining of a tumour, which was situated partly on the cornea and partly on the sclerotic of the right eye.

History.—Forty years ago he met with an accident; a piece of stone rebounded off a wall, struck his right eye; there was no bleeding, but there remained a red spot under the conjunctiva at the point injured. The spot changed in the course of years to a black colour, and remained stationary until seven months ago, when it began to spread and encroach upon the cornea, interfering with his sight. The tumour is the size of a large bean, of an oblong shape, with an elevated centre. It is situated partly on the lower and outer segment of the cornea, and partly on the corresponding portion of the sclerotic, having on each side two black subconjunctival marks, while the tumour itself has a yellowish-brown colour, with fine blood-vessels running through it. It extended over the cornea, covering nearly the whole of the pupil, so that the patient sees a little only when the pupil is in a state of dilatation, and even then objects appear double, as if a foreign body were hanging over it. He can see nothing at all when the pupil is contracted. He was treated as an out-patient for some weeks, and during this time the case was carefully watched. Finding that the tumour had made decided progress, especially within the last month, during which time it had grown so rapidly as to cover the whole pupil, we determined to remove it (June 30th, 1880). This was done by transfixing the tumour along with the epithelial layer of the cornea with a cataract knife, and by a sawing motion removing its corneal attachment; then, seizing this part with the forceps, I dissected it as far as the limbus. It was adherent to the subconjunctival tissue, and to part of the tendon of the external rectus, which I dissected off with scissors. The cornea is now perfectly clear and vision normal. Dr Foulis, pathologist to the Royal Infirmary, examined the tumour, and described it as a *melanotic sarcoma.*

DERMOID TUMOUR—TRICHOSIS

In speaking of the tumours of this region I may call your attention to another tumour, which is found situated partly upon the cornea and partly upon the sclerotic, viz. dermoid tumour or trichosis, which is also of comparatively rare occurrence. Here is a small tumour (Fig. 30), which I have removed from a girl, æt. 13. It is the size of a large horse-bean, and is studded with fine hair. It was situated at the junction of the cornea with the limbus, half upon the cornea and half upon the conjunctiva, where it bulged considerably. I seized it with toothed forceps, and shaved it off the cornea with the triangular knife, and finished the dissection of the conjunctival attachment with scissors. Wardrop[1] records a case of a boy, in which twelve long hairs grew from the tumour, passed between the eyelids, and hung over his cheeks. These hairs did not appear till the age of sixteen, when his beard also began to grow.

FIG. 30.



KERATOGLOBUS—CORNEA PELLUCIDA—DROPSY OF THE ANTERIOR CHAMBER—BUPHTHALMIA

These different designations are applied to a state of distension of the whole cornea, which sometimes reaches such dimensions as to prevent the eyelids from closing over the globe. I have never seen any case other than congenital. Some years ago I operated upon a boy, an inmate of the Asylum for the Blind in Aberdeen, whose keratoglobus was complicated with cataract; one of the lenses was successfully extracted, and a considerable degree of vision restored in the eye without the aid of convex lenses.

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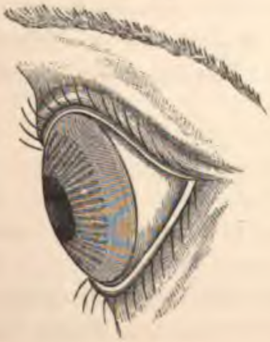
[1] 'Morbid Anatomy of the Human Eye,' vol. i, p. 32.

I have elsewhere[1] recorded an interesting case of the same kind occurring in a weaver; both corneæ were highly transparent, glistening, hemispherical, measuring seven eighths of an inch in diameter, with a diffused bluish haze in the centre; vision was good till the age of fifty-nine, when he had double cataract. I extracted the lens of one eye successfully, so that he was able to do the work of a porter. Here is a case which was admitted to the Ophthalmic Institution July 16th, 1880. William F—, aged 9, an intelligent, fair-haired boy, had enjoyed good health, and his eyes had been normal (according to his father's account) till he reached the age of three years. About that time, after an attack of inflammation, his right eye began to distend, whilst his left remained normal till two years ago, when it likewise began to increase in size. The distension of the right eye, then, is of six years' standing, and that of the left only of two years; yet the left is now worse than the other in point of size, as well as of vision, for whilst with the right eye he sees a little, with the left he can see almost nothing. This is accounted for by the fact that some weeks ago the left eye received a stroke with a boy's cap, and was inflamed for a considerable time after the injury. Both eyeballs are now very large; in fact, the left has attained such a size that the eyelid can scarcely close over it. Fig. 31 represents the

FIG. 31.



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[1] 'An improved Method of Extraction of Cataract,' p. 66, 1860.

left eye (the larger). The cornea has an opaque ring at the scleral border, with fine vessels approaching and covering it for one sixth of an inch all round; the centre of the cornea is so opaque that the ophthalmoscopic image cannot be seen through it. The anterior chamber is distended; the iris is of a dusky-blue colour, with a slit at the ciliary margin, and is pushed back by the aqueous humour; the pupil is undilatable and irregular. All visual power is lost, so that the patient cannot see fingers held before him. The danger in this condition of the eye is that the dropsical effusion, when in a state of progression, is not likely to be arrested, but rather to extend to the choroid, and produce rapid disorganisation.

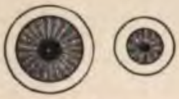
Treatment.—Paracentesis of the cornea is the remedy which will most readily suggest itself to your mind as the most likely means to arrest its progress. It is undoubtedly a safe operation, and may be repeated several times in succession; but, in my opinion, it is capable of affording only temporary relief. The reason of this is that the cornea being distended and the chamber deepened, the fluid will gradually accumulate and refill it. To obtain permanent relief we must reduce the aqueous chamber by giving a smaller curve to the cornea. From the success which I had experienced lately in sclerotomy, in some cases of cyclitis and glaucomatous affections I determined to try it in this case. The result is very encouraging; the globe has not only been considerably reduced, so that the eyelid can comfortably cover it, but vision also has been restored. The patient can see minute objects—can see the difference between a sixpence and a shilling. The iris looks healthy, and the pupil is slightly dilatable.

MICROPHTHALMOS.

The case which has just come to the Institution (March 7th, 1881) forms a contrast to the above.

Miss Effie N—, aged 22, Ayrshire. Right eye is of a normal, rather large size, and blue iris, whilst her left is extremely small, and iris light brown; pupil, although of the size of a pin's head is active. Ophthalmoscopic examination shows posterior staphyloma and atrophy of the choroid. Vision is imperfect. She can count fingers and see large objects, but cannot see the largest type. Fig. 32 is the exact measurement of both corneæ.

FIG. 32.



Absence of Eyeball.—I may also mention in connection with these congenital abnormalities a case of absence of the left eyeball, which was brought to this Institution in July, 1880, the right eye being quite healthy.

The late Dr. J. G. Wilson consulted me some time ago in the case of an infant which he had delivered where both eyeballs were wanting; in one there was a small stump, and in the other the orbit was contracted and no vestige of an eyeball discernible. The infant had also cleft palate and double harelip, and the heart's action was irregular, and lived only about eight months. In these two cases I interrogated the mothers whether they could trace this deformity to some impressions or agitations during pregnancy, but they could not remember any such mental impressions or assign any cause for the occurrence.

STAPHYLOMA

When the cornea is opaque and distended, and the iris is adherent, the condition is called staphyloma (σταφηλωμα). This may be either total or partial. In the case of a small staphyloma, an iridectomy, on the same principle as recommended for hernia iridis, may be performed with every chance of success; but when it is total, and the adherent iris is pushing on in that direction, it is better that the eyeball should be removed. All the methods generally recommended for partial removal of a staphyloma ought, in my opinion, to be abandoned, for whenever you inflict such a wound upon the anterior hemisphere of the globe, the lenticular system being *in sitû*, and the internal structures diseased, you may have as results chronic inflammation and various pathological changes. These changes may range from irido-choroiditis to ossification in the interior of the eye and this in turn may lead to sympathetic inflammation in the other eye. Such a condition of things may creep on insidiously for years; in fact, I have seen instances in which it took thirty years to develop.

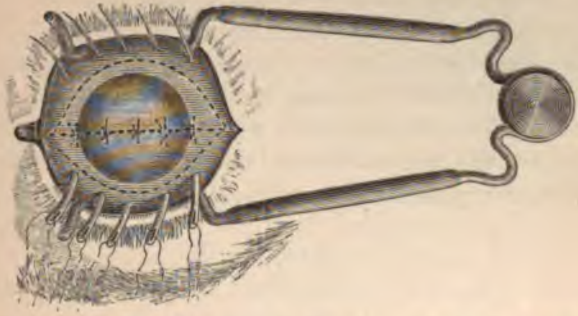
The same objection cannot be made to Critchett's operation of abscission. Where the staphyloma was total, *i. e.* where the cornea was distended and reached the size of the keratoglobus above described and pear shaped, Mr. Critchett introduced the method of removing the anterior hemisphere of the globe beyond the ciliary circle, including the lens. The operation is satisfactory as regards the adaptation of an artificial eye, because enucleation does not in all cases yield a support sufficiently large for the proper movement of a glass eye, so that it sometimes sinks in the socket, but abscission yields a nice moveable support.

I must, however, warn you that abscission is not free from danger. Of course, you will never think of performing it in old people. In the case of adult patients, and especially in young ladies, to whom appearance is of the utmost importance, the operation proves a great boon. But even in adults you must not altogether overlook the condition of the other eye. You must make sure that it is perfectly healthy, that refraction is normal, and that the iris and choroid have never been affected.

When the eye is not in a perfect condition, and especially when the choroid is pigmentous, it is certainly preferable and advisable to enucleate the diseased eye rather than run the risk of injury to the other eye. I have watched cases of disseminated choroiditis running in families, in whom the slightest attack of conjunctivitis or iritis tends to be followed by complications. My advice to you is, do not tamper with an eye having such a tendency, or even the slightest semblance of such a tendency, else sympathia may overtake your patient ere you are aware of it. In suitable cases, however, abscission is a valuable procedure, provided that due care and precaution be exercised.

Operation.—The lids being separated by a speculum and steadied with forceps, four large semicircular curved needles, threaded with silk, are made to transfix the eye at the sclerotic, equidistant from each other, and at such points as the lines of incision are intended to traverse. The needles are left in this

FIG. 33.



Showing the needles in their respective places in the first period; the dotted lines at circumference mark the extent of the abcised part; the ligatures in the centre, the place where the parts are brought together.

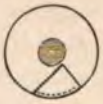
position with both extremities protruding to an equal extent from the staphyloma. Beer's knife is then introduced into the sclerotic in front of the needles, and by a sawing movement the external half of the staphyloma is severed, and the section of the internal half finished with scissors. The needles are then drawn through, first the middle and then the others, and the sutures are carefully tied, so as to approximate as closely as possible the divided edges of the sclerotic and conjunctiva. Dressing consists simply of dry lint and a bandage. The ligatures are left in for six days, and then removed, either all at once or one or two at a time, according to the appearance of the wound.

CORNEAL TRANSPLANTATION

In speaking of conjunctival transplantation, I have incidentally mentioned to you that in cases of burn, when the greater portion of the cornea is rendered opaque, we open a path for the rays of light into the interior of the eye by means of an artificial pupil. A glance at Figs. 19 and 20 will show you that we can utilise very small portions of transparent cornea for that purpose. The question we have now to answer is, "Will cases of complete corneal opacity ever come within the province of surgical interference?" In other words, "Shall we ever be able to restore sight to an eye whose cornea is completely opaque, but which is otherwise healthy?"

My attention was first directed to this subject in 1872, when I operated in a case of traumatic cataract, where the bulging of the lens forward rendered the corneal wound invisible. After the lens came away, however, I found that the injury to the cornea formed two sides of a triangle, which was almost completed by the corneal incision (Fig. 34). We were thus left with a triangular piece of cornea, which, on being replaced, not only adhered but preserved its transparency. After a series of experiments I have satisfied myself that corneal transplantation is not such a hopeless undertaking as is generally supposed.

FIG. 34.



In 1877 I explained the principles of my proposed operation to Dr. Sellerbeck of Berlin, who afterwards successfully transplanted a cornea, which he exhibited to Langenbeck and other eminent surgeons. In a paper which he published[1] he showed that corneal transplantation had long been the earnest aim of German surgeons. Indeed, in 1839, the medical faculty of Munich offered a prize for the best work on that subject; but this led to no practical result, and the subject had completely vanished from ophthalmic literature until Mr. Power brought it again into notice by publishing the details of a case, in which he transplanted a human cornea, which he had preserved in a solution of chloride of sodium.[2]

My conclusions with regard to this subject may be formulated as follows:

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[1] "Ueber Keratoplastik," 'Graefe's Archiv für Ophthalmologie,' Bd. xxiv.

[2] 'Centralblatt für Practische Augenheilkunde,' July, 1877.

1. The cornea can maintain its vitality and transparency when transplanted from one place to another, but must be taken from a freshly enucleated human eye.

2. All the incisions must be clean, as any tearing is likely to lead to suppuration, and the measurements of the graft must be exact.

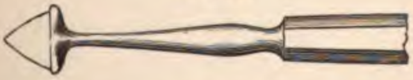
3. It must be done in such a manner as not to damage the subjacent structures. This is absolutely impossible if we attempt the transplantation of the whole of the cornea, because, as soon as we remove it, the lens and vitreous come out, bleeding follows, and loss of vision is inevitable, even if we secure corneal transparency. But the removal of the entire cornea is not necessary, and the chances of maintaining its vitality decrease in proportion to its extent. Hence, if we aim at the restoration of sight by transplanting a transparent cornea, we must content ourselves with a small corneal graft in the form of a stripe from the centre, or a little below the horizontal meridian, along with a conjunctival flap on each side. These conjunctival bands not only assist in keeping the graft in position, but also by their adhesion afford it a chance of preserving its vitality, even if we do not get immediate union between the corneal edges.

In Sellerbeck's operation, already alluded to, he removed a circular portion of the cornea by means of a trephine; but to me the removal of a horizontal stripe seems the path most open to success.

The operation is conducted in the following manner:

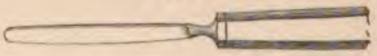
The patient who is to receive the new cornea being put under chloroform, a broad conjunctival band is removed, a little below the horizontal meridian, on each side of the cornea. A lance with a stop (Fig. 35) is introduced into the anterior chamber at the margin of the cornea, as far as the globe will allow it to penetrate, and this is repeated on the opposite side. Having thus obtained the size of the portion of cornea to be removed, a small

FIG. 35.



probe-pointed corneal knife (Fig. 36) is introduced into the anterior chamber; its edge is turned towards the cornea, and made to cut upwards, one section of the cornea being thus completed.

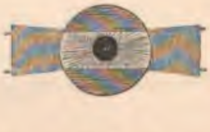
FIG. 36.



In doing this the anterior surface of the cornea must be supported slightly by means of a flat silver spatula, so as to prevent tearing of the cornea or displacement of the deep structures. This step of the operation must be performed without concussion. To remove the other end of the corneal flap we seize it gently with the forceps, and either cut straight down upon it with a cataract knife, or introduce very sharp, flat, probe-pointed scissors, and so divide it. Care must be taken that the iris is not interfered with during the corneal section, or the lens is sure to be damaged; but it is better, if it can be managed with safety, to remove a small piece from the lower segment of the iris. The eyelids are then closed gently till the graft is ready.

To obtain the graft we put the patient from whom it is to be taken under chloroform, and dissect a broad flap of the ocular conjunctiva from each side of the cornea, over which the flaps are turned. The eyeball is then enucleated in the usual way, and the lance introduced into the anterior chamber, and the requisite cornea and the two conjunctival bands carefully removed, as in the former case, and placed in position, being secured by stitches in the corners of the flaps, as represented in Fig. 37.

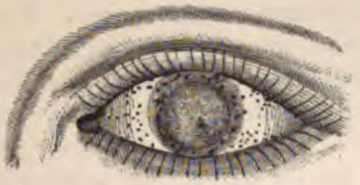
FIG. 37.



The following case, operated upon in October, 1879, will serve as an illustration. John P—, about 40 years of age, met with an injury, about two years previously, from an explosion, by which his hands, face, and head were burned, and his eyes almost destroyed.

At the date of the operation his right eye was completely disorganised, and the conjunctival sac partly obliterated, while the conjunctiva of the left eye (Fig. 38) was studded with

FIG. 38.



gunpowder; the margin of the cornea was covered with false membrane, and the rest of it totally opaque. There was a hole near the centre, through which the iris protruded. The eyeball was soft, but the patient could unhesitatingly point to the flame of a candle moved in every direction, and this sensibility to light was an encouragement to attempt the restoration of sight by corneal transplantation. Having occasion to remove an eyeball from another patient, who thirty years ago had received an injury, which had rendered him blind of one eye, the lens being dislocated into the vitreous, and the eye having become so troublesome as to necessitate its removal, I obtained a healthy graft, according to the method just described.

Being placed in position it was fixed with stitches at the corners of the conjunctival bands. The eyelids were closed and dressed with three strips of court plaster, a pad of lint, and a bandage. On the fifth day after the operation I examined the eye, and found that the cornea and conjunctival flaps were adhering satisfactorily, no inconvenience or discomfort having meanwhile been experienced. Immediate union of the conjunctival bands had taken place, but the corneal edges were distinctly visible. The patient could distinguish features and count fingers held before his face. On the fourteenth day after the operation he could see so well as to be able to point out with his finger a ring on the hand of the examiner. Steady improvement in the power of exteriorating rapidly and accurately took place, and he was dismissed from the hospital six weeks after the operation, when the margins of the corneal graft were but faintly visible, and he could distinguish between a half sovereign and a shilling.

A month later, however, he began to sell lucifer matches in the streets, and from this exposure to the severity of our winter season his cornea became rather opaque. Yet, notwithstanding these drawbacks, not only has the vitality of the graft and its complete incorporation with the tissues been maintained, but also its proper curvature and nearly the normal tension of the eyeball have been restored ($T._1$), and the patient is still able to count fingers, put his finger upon small objects held before him, and distinguishes colours easily. When exhibited at Cambridge, in August, 1880, Mr Bowman and Landolt tested the tactile sensibility of the graft, and found it deficient. This, however, is a minor consideration, for the nervous distribution is likely to return in course of time.

From my attempts in this department I am confident that we shall ultimately succeed in replacing an opaque cornea.

LECTURE VII

DISEASES OF THE SCLEROTIC

GENTLEMEN.—The diseases of the sclera may be divided into *scleritis* and *episcleritis*. Episcleritis is a swelling and hypertrophy of the episcleral cellular tissue and of the superficial fibres of the sclerotic. Scleritis is a deep inflammation of the sclerotic, and is necessarily connected with inflammation of the cornea and iris, or with choroidal complications.

Episcleritis is characterised by a circumscribed redness and swelling, resembling phlyctenular conjunctivitis, except that it is situated under the conjunctiva, and its blood-vessels are easily distinguishable from the conjunctival vessels. It attacks the anterior hemisphere of the sclera, its most frequent site being about one fourth of an inch from the cornea in the direction of the recti muscles, near their insertion. The swelling is first small, reddish yellow at the summit, and of a brighter red colour at the base; gradually it gets larger, forming a hemispherical prominence, the size of a pea or a small bean, and at the same time gets darker, assuming a violet shade.

When at some distance from the cornea it may run a favorable though a tedious course, and gradually disappear in the course of some weeks or months, the violet shade passing into a slate grey, and then becoming lead coloured, and finally fully disappearing, or remaining as a slight discoloration.

The *cause* of episcleritis is unknown, although it is thought to be connected with a rheumatic diathesis, for it sometimes attacks those who are subject to articular rheumatism. Females are more liable to the affection than males, and adults more than young persons. It hardly requires, nor is it benefited by, any course of treatment except the use of warm fomentations, along with rest to the eye, and a bandage and dry compress to favour absorption. The wearing of blue-coloured spectacles is also desirable, to guard against a relapse from atmospheric changes. There is hardly any pain; vision is not in the slightest degree affected, nor is accommodation interfered with, and the only inconvenience is the duration of the disease, together with its liability to recur; otherwise uncomplicated episcleritis has no more danger than phlyctenular conjunctivitis. When, however, it is situated close to the cornea, the inflammation is apt to encroach upon that membrane, and produce partial opacity, and there is also some risk that the episcleritis may extend to the deep layer of the sclera, and result in staphyloma of the choroid.

Scleritis.—For a long time I refused to admit the existence of primary inflammation of the sclera, and was in the habit of teaching that what was generally called scleritis was merely *ectasia* of that coat, caused by the inflammation of the iris, ciliary circle, or choroid, inducing effusion into the tissues and augmentation of the vitreous, which presses upon and distends the sclera; but careful attention to the progress of some cases of staphyloma of the choroid convinced me of the primary inflammation of the sclerotic. Our chances of observation are comparatively rare, but when they do occur we notice that the choroidal staphyloma progresses without any intraocular pressure and without any sign of iritis, and hence, the existence of choroiditis being excluded, we are shut up to the conclusion that the sclera is the primary seat of the inflammation. Indeed, cornea, iris, and choroid complications are the most disastrous consequences of deep scleritis.

Kerato-iritis complications.—In these cases scleritis generally begins with very severe inflammation of the whole of the conjunctiva, accompanied by great pain and lachrymation, the injection being particularly marked at the limbus, a segment of cornea becomes involved, and presents a small opaque appearance; there is sluggishness or immobility of the pupil, and the ciliary border of the iris is engorged. At a later stage the iris becomes adherent to the lens capsule, the aqueous humour gets muddy, and the anterior chamber somewhat deeper than in the healthy eye, while tension is higher than normal, and you will notice particularly the heightened sensibility to touch.

During this stage the disease does not show its localisation, but when the inflammatory symptoms subside a distinct swelling of the sclera becomes visible, forming a livid grey-red hemispherical elevation near the cornea, whilst the cornea presents a greyish-white inflammation, which may extend to the centre, and the sclera becomes thinned and more yielding. You will, therefore, perceive the danger of dropsy of the aqueous extending into the deeper structures, and causing irreparable damage to the eye.

This condition calls for active local and constitutional treatment.

Both eyes and body must have absolute rest; locally, a strong solution of atropine must be used three or four times a day, along with warm fomentations. Unguent. Hydr. c. Belladon. should be rubbed in round the orbit, and blisters applied both to the temple and behind the ear, dry compresses being used at night. Mild cathartics and tonics may be administered, and the application of twenty or thirty leeches round the orbit is recommended by great authorities.

With regard to operative interference, I think *paracentesis*, two or three times repeated, the only operation applicable to this disease in the first stage; and, if I may be allowed to put a comparative value upon remedial measures, I would say that one paracentesis is worth all the leeches we may call to our aid.

Iridectomy should be performed only after the disease has spent itself, for when the acute symptoms have disappeared, and the iris has formed adhesions, we are in a better condition to judge which part of the iris ought to be excised for therapeutic or optical purposes; and during the progress of the disease an iridectomy might have a tendency to complicate matters.

Choroidal complications.—Sclerotitis nearer the equator follows, as a rule, a more chronic course; a circumscribed patch of the sclera loses its white colour and assumes a dusky hue; gradually this becomes more limited in extent, and presents a small elevation the size of a pea, through which the dark choroid shines. It may come on gradually without indication of its approach, and we only become aware of it when lifting the eyelid, or when the patient turns his eyeball in abduction the nodules become visible.

As a rule, such a small nodule may exist without affecting vision in the slightest; but when there are two or three such nodes vision is deteriorated, and it is this deterioration which causes the patient to apply for advice. It is a serious condition of things, for the choroid may already be atrophied and adherent to the distended sclera, and the corresponding part of the retina may either be dragged along the scleral staphyloma and atrophied, or it may be detached and float about in the vitreous, which becomes soft in that spot, in the whole of its anterior part.

The distension of the sclera at the posterior part of the eye, near the entrance of the optic nerve, called *posterior staphyloma*, we can study more minutely by means of the ophthalmoscope, and we shall consider this subject in a subsequent lecture.

DISEASES OF THE IRIS

The iris is not only liable to suffer from various forms of inflammation, but may also be implicated in any acute protracted disease affecting either the conjunctiva, the cornea, its neighbouring episcleral region, the ciliary muscle, or the anterior part of the choroid.

When a foreign body is lodged for any length of time in these structures you may always judge of the gravity of the case by the appearance of the iris, by its change of colour, by its dry look, and by the sluggishness or irregularity of the pupil; for the severity of every disease in, or accident to, these tissues is marked upon that membrane. In your examination of the iris—

1. Direct your attention to its colour; compare it with the healthy iris of the other eye, and see whether it has undergone any change, for inflammation here changes blue into greenish, brown into reddish, and grey into a greenish-yellow colour.

When blood is effused into the anterior part of the vitreous the iris presents a peculiar green colour.

The arterial distribution will account for this change of the iris and its sympathy with the other structures. The anterior ciliary arteries, which supply the recti muscles, perforate the sclerotic near the cornea, and upon the ciliary muscle they unite with the posterior (long) ciliary to form the arterial circle of the iris. Before penetrating the sclerotic the anterior ciliary arteries give off branches to the episcleral regions and to the limbus conjunctivalis, from which the cornea derives its principal nourishment. Hence, in disturbance of the circulation of either the anterior or posterior ciliary arteries, blood is effused into the iris, the addition of which to its natural colour gives rise to the change in question. That the arterial relation is the cause of the change is evident from the fact that the posterior part of the choroid and optic nerve may be inflamed and the retina detached without producing any change in the colour of the iris, or having any effect on the action of the pupil.

2. See whether the iris presents its natural glistening surface or has a dry look.

3. Examine the state of the pupil, cover the eye with the eyelid for a little; then lift the lid, and see whether it contracts readily, or is sluggish in its movements.

4. Put in a few drops of atropine solution, and see how it responds to the action of this mydriatic. Notice whether it dilates regularly, or if the pupil is drawn to one side; and in the latter case see if it arises from adhesion to the lens-capsule or from thickening of the undilatable segment. Direct a pencil of light upon the pupil, and see whether there are any black or brown spots upon the capsule, indicating a former attack of iritis or old adhesions.

5. Examine the pericorneal regions. When the iris is inflamed there is injection round the cornea, which may be very slight. The chronic form of inflammation, indeed, may creep on without any or with imperceptible pericorneal inflammation; but in every acute attack there is a rosy zone of parallel vessels, closely ranged round the cornea, and striated behind the conjunctiva.

There may also be chemosis, which is sometimes very considerable, especially in traumatic, though rarely in idiopathic cases, so that the limbus is raised like a red or bluish-red ring round the cornea.

The swelling of the conjunctiva may go on to a considerable extent, and involve the subconjunctival tissue and upper eyelid, which also becomes œdematous.

This is a general outline of the local symptoms of inflammation of the iris. In an acute attack we have, besides, the following:

General symptoms.—There is lancinating pain, situated at first in the interior of the eyeball, and then extending to the forehead, temple, and gums, and to some other branches of the fifth nerve. When accompanied with throbbing this indicates an unfavorable condition of things, for when long continued it is generally a sign of the commencement of suppuration. When there is violent pain in the back of the head it shows the presence of irido-choroiditis.

The pain increases towards evening. Sometimes it commences at midnight and lasts till morning, when it has assumed the character of a dull aching pain in the eyeball, and is occasionally of a lancinating nature. These nocturnal exacerbations may cause constitutional disturbance—feverishness and impaired appetite—and in children cerebral disturbance may be produced.

Photophobia and lachrymation are rarely altogether absent, but are generally very slight, and never in the same degree as in keratitis.

Forms of iritis.—The different forms of inflammation of the iris may be divided into—1. Hyperæmia of the iris. 2. Plastic iritis. 3. Serous iritis. 4. Parenchymatous. 5. Syphilitic.

Simple hyperæmia of the iris is caused by irritation of those parts which have an arterial relation to the iris. It is characterised by pericorneal injection, and the changes of colour just mentioned are particularly well marked on account of the clearness of the aqueous humour, which undergoes no change. There is also sluggishness of the pupil; the line of demarcation, however, between simple hyperæmia and change in the stroma of the iris is so faint that it is sometimes difficult to say when the one ends and the other begins; the same case may one day be simple hyperæmia and the next acute inflammation of the iris.

When a foreign body is lodged in the corneal epithelium there is inflammation of the conjunctiva, but when the foreign body is lodged in the cornea proper the inflammation extends to the ciliary circle and iris, and we have hyperæmia. This condition, when long protracted, leads to a change in the stroma of the iris—exudation of fibrine. When the foreign body is lodged in the ciliary circle the transition from hyperæmia to suppuration is very rapid. The following is a case in point:

Foreign body lodged in the ciliary region, looking to the aqueous chamber.—James C—, age 21, irondresser, was admitted into the Ophthalmic Institution on the evening of September 14th, 1880, with a piece of steel in the left eye. The foreign body struck the cornea a little below the centre, and in a downward, slanting direction, traversed the aqueous chamber, and became entangled in the ciliary region. Two hours after the accident a small glistening part of the steel could be seen upon the ciliary margin of the iris, the aqueous humour being clear, and the iris slightly hyperæmic. The eye was dressed and the patient sent to bed. Next morning we found the iris thickened by exudations and the pupil immovable, a thin membrane having already formed, which filled the whole area of the pupil. The foreign body could not be seen, being enveloped in a greyish membrane. Indeed, this was the beginning of the suppurative stage. The steel was extracted, and two days later we found a small quantity of pus at the site of the injury.

In cases of comparatively slight accidents to the cornea with pieces of coal the inflammation rapidly spreads to the iris, and produces hypopion. Bearing these facts in mind you will be able more readily to appreciate the nomenclature generally adopted by writers. You will take them as broad landmarks to guide you in your study, but will understand that there are many intermediate stages presenting characteristic features, which cannot be limited to any of these classes.

Plastic iritis is characterised by an effusion of lymph at the edges of the pupil and into the stroma of the iris. The exudation may extend to both surfaces of the iris and to the aqueous humour, which becomes turbid. The pupil becomes cloudy, and is covered by a thin web of fibrine, and hence we find loss of brilliancy of the iris, which has a dry look. Immobility of the pupil is more complete than in hyperæmia, but change of colour is not so well marked on account of the turbidity of the aqueous humour, and also on account of the change in the stroma of the iris. This condition, when pushed to any extent, or when not relieved by mydriatics, may lead to permanent adhesions of the iris-circle to the lens-capsule (synechia posterior), and the pupil may become obliterated.

Serous iritis.—Dropsy of the aqueous chamber.—In this form of iritis there is a hypersecretion of the aqueous humour, instead of a fibrinous exudation. It generally pursues a chronic course. Pericorneal injection is less marked than in the plastic form, the aqueous humour is less turbid, discoloration of the iris is slight, the pupil is slightly dilated and pushed back by the aqueous humour, leaving a deep anterior chamber, Descemet's membrane is cloudy, and sometimes assumes the form of punctative keratitis. Tension of the eyeball is increased, and it is this increased tension of the eyeball which renders this form of iritis very dangerous, for if not arrested it may give rise to irido-choroiditis and to glaucomatous complications.

Parenchymatous iritis consists in a swelling of the membrane and hypertrophy of its cellular elements. New-formed blood-vessels appear upon its surface, along with small papilliform elevations; and the change in colour of the iris, although present, is not so well marked as in hyperæmia. This form has a great tendency to be followed by posterior adhesions, which take place at the various elevated points, and sometimes by suppuration, which pursues a very rapid course.

Syphilitic iritis is only another form of the parenchymatous variety. Its chief distinctive characteristic is that, instead of the whole iris being studded over with excrescences, the disease is confined to one or two spots, whilst the rest is of perfectly normal appearance. One fourth or one half of the iris is changed in colour and swollen; blood-vessels form upon it;

then small ulcerations are formed, called condylomatous nodules or pustules. These pustules may occupy any part of the iris, and the pupil may be dragged towards that part.

Virchow describes condylomata as gummy tubercles, and this has subsequently been confirmed by Colberg, who found that they were composed of a cellular element of new formation, with a large number of free nuclei surrounded with a mass of blastema; there were also some spindle-shaped cells disposed in lines, the vestiges of vessels in process of formation.

Syphilis may give rise to serous or other forms of iritis, but these pustules or condylomata of the iris are so characteristic that, whenever a patient presents himself with such a form of iritis, you may safely ask him when he had a chancre, and you will find either that he is at present suffering from a primary sore or that he suffered some time ago, and had been improperly treated, or not treated at all.

It is remarkable how little photophobia or lachrymation there is in some of these cases, especially at the commencement of the affection. Some of the out-door patients at the hospital get cured without being confined a single day to the house; but when neglected, and the disease allowed to run its course unchecked, the inflammation extends to the ciliary circle, and then there is the accession of all the symptoms of acute iritis. The same is the case in a relapse. There is, besides, in these neglected cases, the risk of its extending to the choroid and retina, terminating in choroido-retinitis.

Cause.—I have already mentioned to you incidentally that iritis may be caused by injury to the iris itself, or to those parts which stand in arterial relation to it.

With regard to the iris itself, iridectomy shows us that this membrane may be cut, and a portion of it removed with perfect impunity; but when it is lacerated, bruised, strangulated in a wound, or caught in a cicatrix, the danger is great, not only to the deep structures of the same eye, but to those of the other eye. I shall return to this subject in our consideration of sympathetic inflammation.

Idiopathic iritis may attack persons of all ages. Syphilitic and gouty-rheumatic and strumous subjects are most liable to it.

Among the *exciting causes* may be mentioned exposure to sudden changes of temperature, cold draughts, a severe drenching; anxiety, grief, and sleeplessness may induce it in persons predisposed to congestion of the internal structures of the eye.

Treatment.—Our efforts must be directed to obviate the tendency to adhesion, and to effect this we have a powerful agent in atropine. V. Graefe and Donders have shown how rapidly this substance is absorbed by the tissues; and it has been found that the aqueous humour drawn from an atropinised eye of a rabbit contains as much of the alkaloid as is sufficient to produce mydriasis in another animal. In recent cases of iritis, when the adhesions are fresh, we find that the installation of the atropine solution breaks up the adhesions and the fibrinous exudations in the area of the pupil, and puts the eye at once in a favourable condition for resolution. The solution in cases of iritis must be strong (six grains to the ounce), of which six drops should be used three times a day.* The eye should be kept closed and painted over with the Extract. Belladonnæ, or grey ointment is applied to the eyebrow and temple.

V. Graefe, Desmarres, and all eminent ophthalmologists recommend leeches to the temple, and it is generally thought that the abstraction of blood facilitates the action of the atropine and other remedies; but I have no experience of leeches. Laxatives are of great importance as favouring the action of both local and internal remedies.

It is well to begin with blue and colocynth pill or Ol. Ricini, according to circumstances, followed up by warm drinks and foot-baths, to promote the action of the skin. This treatment, followed up by a mild mercurial course, consisting of hydr. and quinine pills, is generally sufficient, in the course of a week or ten days, to prevent complications.

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* In some patients, the application of the solution of atropine produces erysipelas of the face. For such idiosyncrasies Ernest Hart and Streatfeild have introduced gelatine discs, which may be safely applied, as, on being placed in the conjunctival sac, they dissolve gradually.

When adhesions have already taken place the atropine solution should be less strong, and administered only once a day, the eyelid being kept painted with the Extr. Belladonnæ, The patient must avoid alcoholic drinks altogether, and this rule must be strictly adhered to in all the internal affections of the eye.

With regard to operative interference, a large iridectomy is recommended by one writer, but such an operation ought never to be performed. Do not touch an iris in a state of inflammation, or you will find that it will resent your interference, and the pupil you have made will soon close. If you cannot prevent adhesion by medical treatment let the inflammation take its course, and you will have an opportunity, some six months later, of operating for artificial pupil with more chance of success.

A paracentesis may be necessary when you see that the iris has a tendency to suppurate; and in serous iritis paracentesis is not only desirable, but absolutely necessary, and sometimes two or three repetitions of the operation may be required to prevent the dropsical infiltration extending to the choroid. An eye affected with syphilitic iritis should not be touched with an instrument on any account, not even for the performance of a simple paracentesis.

In cases of syphilitic iritis the following course may be adopted:—After the administration of Pil. Hyd. c. Colocynthidis, order Ol. Terebinth., half a teaspoonful three times a day, in Syrupi Aurantii, and continue this for some days, with warm drinks and foot-baths. Then order Pil. Hyd. c. Quiniæ three or four times a day, and the Unguent. Hydr. ʒj to be rubbed into the armpit every day; warm baths may be taken twice a week.

When the gums begin to get tender discontinue the pills, and give internally potassium iodide. Should symptoms of mercurialisation supervene discontinue the ointment also, and keep the patient exclusively upon the Iod. Potass., of which ℈j may be given three times a day. The strong atropine solution with grey ointment should be used for a considerable time. The drops may be persevered with for a month or longer after the general inflammatory symptoms have disappeared.

Functional Derangement of the Iris

These are—

1. Dilatation of the pupil—mydriasis.
2. Contraction of the pupil—myosis.
3. Tremulous iris.

You have already seen that the iris regulates the quantity of light to be admitted into the eye, and that it is controlled by the "motor oculi," which contracts the sphincter iridis, and by the sympathetic, which supplies the dilator.

From the retina an impression is conveyed to the brain by means of the optic nerve, and is then reflected through the motor oculi, causing the iris to contract. In strong light, therefore, the pupil contracts, and in darkness it dilates. When the retina is insensible to light no impression is conveyed to the brain, and there is, therefore, no reflex action to cause the pupil to contract, and it remains permanently dilated. On the other hand, the movement of the iris may be perfect, and yet there may be complete blindness, when the conducting power of the optic nerve and the reflex action through the third are unimpaired, but the existence of brain lesions prevents the patient from perceiving the image formed upon the retina, and exteriorating it.

You are aware that the functional derangements of the iris are sometimes sympathetic with cerebral and other diseases; thus, dilatation of the pupil is caused by concussion of the brain, hydrocephalus, and poisoning with coal gas, lead, or belladonna; while contraction of the pupil, on the other hand, may be the result of disease of the pons Varolii, hydrophobia, or poisoning with opium. In apoplectic effusion at the base of the brain there is, at first, dilatation of the pupil, while in the state of reaction the pupil is contracted. In basilar meningitis, on the contrary, the pupil is at first contracted, and in the advanced stage dilated. In hysteria the pupil is contracted at the commencement and dilated during the attack. The pupil is also strongly contracted in cases of obstinate constipation, or in irritation of the digestive organs.

In locomotor ataxia there is in the first stage, as shown by Argyll Robertson, immobility of the pupil to light (abolition of tactile sensibility), while its action is unimpaired in accommodation for near objects; but when the disease is well developed, and especially when the spinal nerves are involved, the pupil becomes widely dilated.

The change in the action of the pupil in these diseases, however, falls within the province of the physician, and in ophthalmology we are more concerned in idiopathic derangements of the iris. When you bear in mind that contraction as well as dilatation of the pupil may be caused either by irritation of the corresponding nerve, or by paralysis of its antagonist, you will readily appreciate the *modus operandi;* thus:

Idiopathic mydriasis is an abnormal dilatation of the pupil, with immobility of the iris. It is generally confined to one eye, being rarely binocular, although it disturbs binocular vision, until the patient has accustomed himself to suppress the indistinct image of the affected eye. It is generally caused by paralysis of the third nerve (paralytic), and only occasionally by irritation of the sympathetic (spasmodic). The affection may be limited to the nerve-fibres which supply the sphinctor iridis, or it may involve those which supply the ciliary muscle, when accommodation may also be interfered with. The dilatation may be partial, or so complete that the iris is concealed behind the *limbus conjunctivalis.* It may supervene without any persisting disease or inflammation, but is sometimes traumatic, caused by a blow on the eye or on the head. Cold, after perspiration, is a common cause of mydriasis, and the irritation of the sympathetic may be induced by intestinal worms, while rheumatism may also cause it.

Mydriasis is sometimes congenital. An official of this ophthalmic hospital has had the pupil of his left eye permanently dilated from infancy, and has never been inconvenienced thereby.

Treatment.—Constitutional treatment is the most reliable, antiphlogistic, antirheumatic, or anthelmintic, according to the exciting cause. You should study carefully the cause of mydriasis, for it may be the precursor of serious brain affection. If it arise from lesions of the third nerve, local faradization may be of some use, especially when combined with the exercise of the internal rectus in converging the optic axis, and thus stimulating the third nerve. Mercury and Iod. Potassium are the most reliable drugs in this case, not on account of their antisyphilitic action, but from their usefulness, as shown by experience, in all cases of paralysis of the ocular muscles of undoubted idiopathic origin. I have tried paracentesis of the cornea, and then touching the iris with a thin silver probe; but I find that as soon as the aqueous humour had collected, the iris dilated again. Eserine is equally disappointing in its effects.

Idiopathic myosis is that condition of the iris in which, without any preceding inflammatory condition or adhesion, the pupil is abnormally contracted to the size of a pin's head or even the point of a needle, remaining perfectly circular and black, and reacting only slightly or not at all to atropine. It limits the field of vision, and images are indistinct. As already indicated, it may be caused by irritation of the third nerve, or by paralysis of the sympathetic. This may be the case in direct compression of the sympathetic in the neck by a tumour, or may be associated with nystagmus (rolling of the eyeball).

Treatment must be directed to the cause of the disease, and if both irides are affected the formation of artificial pupil is the only remedy.

Tremulous iris.—I still adhere to the old opinion, that the principal cause of this condition of the iris is a high degree of softening of the vitreous humour, either in its totality or throughout a considerable portion of it; for I have carefully examined my cases of extraction of cataract, and find that tremulous iris after extraction is the exception. After dislocation of the lens, however, when the zonula has been ruptured, the iris is tremulous. This condition does not call for any treatment.

LECTURE VIII

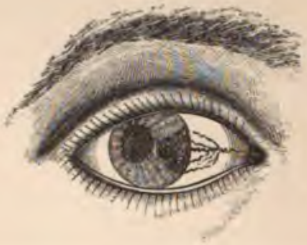
BLEEDING TUMOUR OF THE IRIS

GENTLEMEN,—Heteroplasias of the iris are comparatively rare, and are generally cystic or pigmentous, or, if malignant, most frequently melanotic. The tumour which I am about to describe is very rare indeed. Prof. Hirschberg, who saw the case, says it is only the second on record, the first being one recorded by v. Graefe, and calls the tumour "Granulations Geschwulst"—granulation tumour.

Mr. C—, aged sixty-two, merchant, consulted me in May, 1879, for an eye affection of forty years' standing. He had always enjoyed good health, until one cold winter day he put on thin boots, got his feet wet, and was attacked by severe influenza, complicated with inflammation of the eyes; since that period he has suffered from dimness of vision. His hearing was also affected at the same time; it first became morbidly acute, then dull, and he is now very deaf. He has had no rheumatism nor exanthematous disease, and there is nothing remarkable in the family history. He has had eight children, of whom six are alive; one of his daughters, twenty-one years of age, suffers from epileptic fits.

His right eye shows diffused corneal opacity from old keratitis; the pupil is not dilatable by atropine on account of a false membrane in front of it, which is not intact, but presents a fenestrated appearance. On the cornea of the right eye there is a thin nebula; the pupil is irregularly dilatable, a tumour being situated upon the iris, from the circular fibres down to the ciliary border, and encroaching upon the membrane of Descemet. When a pencil of light is directed upon it, it seems to have an attachment both to the iris and cornea. It is lobulated, of a dark raspberry colour, and dips deeply backwards into the ciliary circle, in which region opacity of the lens has already commenced. Fig. 39 gives the exact shape and position of the tumour, and shows also large subconjunctival vessels proceeding to it.

FIG. 39.



The peculiar characteristic of this tumour is that, at intervals of from four to six weeks, it bleeds, the blood filling the anterior chamber, owing to which, vision is obscured for a week or ten days, when the blood is absorbed and sight re-established.

When it was explained that, from the situation and attachment of the tumour, any attempt at removal was apt to give rise to profuse hæmorrhage and other complications, and also that, at no distant period, the opacity of the lens would become completed, requiring extraction, the patient preferred to do without surgical interference in the meantime, especially as he derived considerable benefit from the application of atropine.

But in the middle of October, 1879, he presented himself with a quantity of blood in the anterior chamber, so profuse as to fill it up and push the iris backwards. In this predicament I recommended a paracentesis to remove the blood. I introduced a speculum, and fixed the eyeball with forceps at the upper vertical meridian, and with a broad needle pierced the corneal circumference at the lower margin. The quantity of blood which issued was alarming, and no sooner was the anterior chamber cleared than there was another gush, and we had to deal with a succession of these. We were, however, unremitting in the pumping process, until at last the flow of blood seemed to be exhausted, and the aqueous humour was only thinly coloured. Four days after, the anterior chamber cleared up entirely, and since then (now twenty-one months ago) there has been no recurrence of bleeding. This is the longest respite he has ever had, and the tumour is now rather less in size, the broad haze having gradually disappeared. When he first came he could not distinguish any type, but now he can see with the left eye No. 12 Snellen. I deem it worth while to call your special attention to this case, both on account of its rare occurrence and the alleviation of the symptoms by paracentesis.

Injuries of the Sclerotic and Iris

It is remarkable to what extent tears in the sclerotic heal without detriment to vision, even when accompanied with prolapse of the vitreous, if the wound be not very coarse. Not long ago Mr John R—, a large millowner, while superintending the trial of a new engine, was struck by a piece of iron, which made a horizontal section of the sclerotic of the left eye to the extent of a quarter of an inch, permitting some escape of vitreous humour. I was soon in attendance and stitched up the wound, which healed without the least impairment of vision.

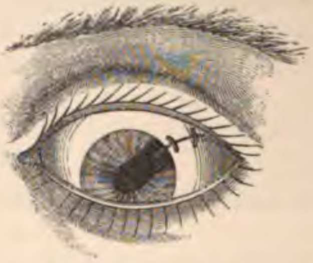
Injuries of the iris.—When the iris is compromised in the scleral wound the danger is much more serious, and when a portion of the iris protrudes through the wound in the sclerotic, it becomes necessary to remove the protruding portion, so as to set the rest afloat in the aqueous humour. There is generally some bleeding into the vitreous in such accidents.

The case is still more complicated when the laceration involves the iris and ciliary margin, producing hernia in that region.

The part of the iris which protrudes through the opening should alone be removed, while the ciliary circle must on no account be interfered with, and the conjunctiva should be brought together with fine sutures, so as to favour the return of the hernia. From my own experience, and from that of others, I have come to the conclusion that excision of the tissues of the ciliary region is apt to terminate in suppuration of the globe.

Case.—David M'C— was admitted January, 1880, with a tear in the upper and outer margin of the cornea and ciliary region of the left eye, the iris and ciliary muscle protruded, and the anterior chamber was filled with blood; the eyeball was soft, and there was no vision. I resected the iris at the margin of the cornea, but the rest I brought together with two silk ligatures (as shown in Fig. 40). I made at the same time a puncture in the lower margin of the cornea, letting out the blood in the anterior chamber. Forty-eight hours after the operation the patient was able to see, and on the fourth day the ligatures were removed.

Fig. 40.



Taken before removal of ligatures.

Formation of Artificial Pupil

This operation has for its object the opening of a passage through the iris for the rays of light, when the natural passage is closed or occluded by some pathological condition. It was first performed by Cheselden in 1728, and for a long period was considered a dangerous operation, which ought to be resorted to only in desperate emergencies. But, owing to improved methods, it is now frequently performed without risk or danger, and, indeed, it is one of the safest operations, and yields very satisfactory results. If properly done, it may even be practised on out-door patients.

We form an artificial pupil in the following cases:

1. In *central opacity* of the cornea, when so extensive as to obstruct vision and annoy the patient when facing the light. In this case we make the pupil opposite the transparent portion of the cornea.

2. In *zonular cataract, i. e.* when there is a transparent zone at the margin of the lens, and hence we direct the pupil so as to face the transparent portion of the lens (see "Zonular Cataract").

3. When the natural pupil has been closed by adhesion to the lens-capsule (posterior synechia), either simply or when it has been occluded by a false membrane.

4. When the iris is adherent to Descemet's membrane (anterior synechia), but more particularly when there is a *leucoma adherens*. In these latter cases an artificial pupil may become necessary, not only for optical effect—for the restoration of sight—but to prevent the injurious consequences resulting from dragging of the iris, which is involved in the cicatrix, as this might induce choroidal and other structural changes.

5. Although I stated that in cases of iritis the iris should not be touched until the inflammatory process has long passed away, it is necessary to bear in mind that the contrary ought to be the rule in cases of hernia iridis. Whenever the cornea is perforated, and the iris protruding from pressure forwards by the aqueous humour, neither pricking nor cutting of the hernia will do any good, while the formation of an artificial pupil will act instantaneously, as it releases the constriction, and thus allows the hernia to recede, and the cornea to granulate over it gradually. The operation being a safe one, we ought to practise it, even when the other eye is quite healthy, for it is always a prudent thing to provide for emergencies, and two eyes are better than one, although the one may not be quite so perfect as that which is normal. On the other hand, when the patient has only one serviceable eye, in which the pupil is contracted, although vision be imperfect, it should by no means be touched, as interference in such a case might injure the little sight which the person has. I have

met with some sad cases of blindness, in which a young practitioner had endeavoured to mend the sight of the only eye which the patient had to rely upon.

It should not be performed in recent cases of occlusion caused by iritis. We must rather wait for some months, until every vestige of inflammation has passed off, for otherwise dormant mischief may be awakened, and destroy any subsequent chance of restoration of sight.

In cases of occlusion from syphilitic iritis you should wait for more than a year, during which time mercury, alternated with potassium iodide, should be regularly administered, and you should make sure that no trace of the virus remains in the system. During all that period there must be no trace of eye inflammation—neither hyperæmia nor conjunctivitis—the condition being perfect health of all the ocular tissues.

We operate for artificial pupil at all ages, either in cases of old people or of children two years old, who have anterior adhesion resulting from infantile ophthalmia, and it is most interesting to notice the change of physiognomy of infants after sight has been restored. In these cases it is necessary to avoid delay, because the children will contract the habit of rolling or oscillating the eyeball, and the deep structures will by-and-by become involved in the disease. This applies with particular emphasis to cases of anterior adhesions at all ages, because the dragging of the iris is apt to tell upon the choroid and the other deep tissues, and abolish vision.

We must ascertain beforehand whether tension be normal, for a soft eye implies choroiditis, and perhaps detachment of the retina, while the existence of retinal disease can be pretty nearly ascertained in adults, although not in infants. It is of importance also to know whether the lens be opaque, for if that be the case the pupil must be made in such a direction as to facilitate the extraction of the cataract.

Operation.—In cases of central opacity or zonular cataract, when the iris is free from adhesions, we operate in the following manner (Fig. 41):—The eyelids being kept open by a speculum, and the eyeball fixed with forceps, the narrow curved lance is passed into the anterior chamber through the conjunctiva, half or one line from the corneo-scleral junction, at the inner and lower segment, and is slowly withdrawn, pressure being made at the same time at the scleral lip of the wound, in order to cause the iris to protrude. If the iris advance, and follow the course of the withdrawn lance, it is seized with small iris forceps (Fig. 42) at the pupillary border, and a vertical cut is made into it without touching the ciliary margin; then with two other cuts the iris is trimmed round, and the rest is returned to float in the aqueous humour. If, however, the iris do not follow the lance, Tyrrell's hook (Fig. 43) is introduced flatly into the anterior chamber until it reaches the pupillary border, which is caught and withdrawn, and then seized with the iris forceps and cut round. Care must be taken in withdrawing the hook to turn the point in such a way as not to catch at the lip of the wound. It may even be necessary to enlarge the conjunctival wound with scissors, in order to give free exit to the hook. In this manner we are able to imitate the appearance of the natural pupil; and it is important not to

Fig. 41.

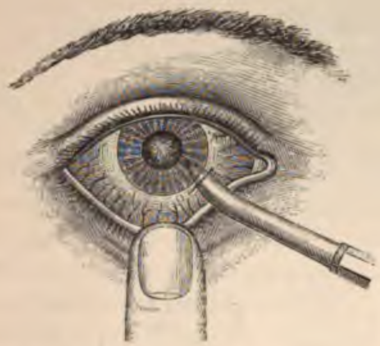


Fig. 42.

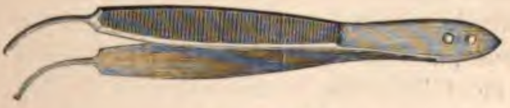
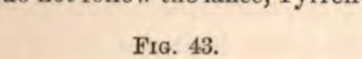


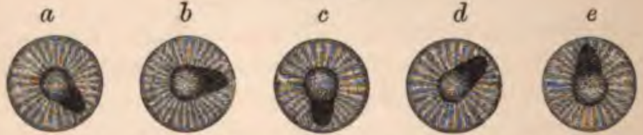
Fig. 43.



make the pupil too large, as in that case you may do positive harm, for the patient can see better through a leucoma, when the natural pupil is dilated, than with a large coloboma iridis cut at random.

Place of selection.—The best place for the formation of artificial pupil is downwards and inwards, so that the rays of light may fall upon the macula; somewhat less advantageous is straight inwards; while the third in point of choice is straight downwards; and the next upwards and inwards, and lastly, straight upwards. Fig. 44 represents artificial pupil in the right eye in the order (*a*, *b*, *c*, *d*, *e*) in point of selection. A pupil directed outwards when the other eye is good is hardly of any use for practical purposes. I may also remark that a pupil directed straight upwards, when there is a central opacity of the cornea, and the eyelid does not rise beyond the opaque spot, can be of little use. The section of the superior rectus muscle has been recommended, so as to cause the globe to protrude more (producing slight exophthalmos), in order to render the pupil serviceable. I have in a similar case, and with satisfactory result, lifted the eyelid by removing a skin flap, and this can be practised to a considerable extent.

FIG. 44.

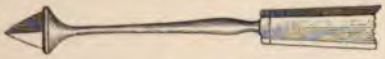


Iridesis.—To avoid the inconvenience of a large pupil, Mr Critchett introduced the operation of iridesis—tying a small portion of the iris—which answers well; but, unfortunately, it was found that this is apt to give rise to anterior synechia and all its injurious consequences.

You must also take care, in cases of corneal opacity, to examine the cornea carefully by focal illumination, and see how far the opacity extends, for with the naked eye we are apt to be deceived on that point, as in opaque cornea the portion lying on a black ground (the pupil) is more readily seen to be opaque than that part which is opposite the iris; and, therefore, unless this source of error be eliminated, we may discover, after the iris section, that the corneal opacity is more extensive than you took it to be, and the result is disappointing; whereas this should rarely or never occur when the eyes are carefully examined, and the work properly executed.

In cases of posterior adhesion, or when the pupil is occluded by a false membrane, the broader lance is used (Fig. 45), and the iris drawn out gradually by means of the forceps, and rounded off if possible; but you will very likely find the iris atrophied, and then you cannot shape it at will.

FIG. 45.



When the presence of an opaque lens is suspected the puncture should be made with the broader lance (Fig. 45) in the lower or upper vertical meridian; and the coloboma must, in these cases, be made rather larger, because, when a false membrane and an opaque lens are present, the chances are that a small pupil will contract. In cases of staphyloma or "hernia iridis" it is best to make the pupil exactly in the diameter opposite the hernia; but, if that would not answer optical purposes, these must have the primary consideration, for an iris section in any place answers therapeutical purposes.

Iridotomy.—De Wecker introduced another operation for artificial pupil, consisting in puncturing the cornea, and then making a simple slit in the iris by means of scissors devised by him for this purpose.

This operation may be useful in cases of spontaneous dislocation of the lens, otherwise I think it rather hazardous to work with scissors in the anterior chamber.

ON SYMPATHETIC OPHTHALMIA

When certain injuries have been inflicted upon the eye, loss of vision of the uninjured eye is almost sure to follow sympathetically, unless prompt measures be adopted to guard against this danger. Although this principle is assented to in theory, it would seem as if in practice it were entirely neglected, if we are to judge from the number of incurable blind persons who present themselves, owing their condition to sympathetic inflammation.

The accidents which give rise to this affection may be arranged in the order of their gravity, as they occurred in the numerous cases in my own practice, as follows:

1. Foreign bodies impacted in any part of the eyeball, and especially in the ciliary region.

2. Dislocation of the lens when pressing on the ciliary region, where it acts the part of a foreign body. In these accidents the inflammation invades the uninjured eye shortly after the injury.

3. Wounds of the sclerotic when some of the ciliary nerves are included in the cicatrix.

4. Any injury to the inner structures of the eye causing protracted inflammation. In these the sound eye may escape for a time, but may ultimately be involved.

I may mention here also that—

5. Any protracted internal inflammation of the eyeball, accompanied by tenderness on pressure in the ciliary region, may cause sympathetic inflammation.

The sympathetic action seems to be set up through the agency of the fifth nerve, either alone or in conjunction with the sympathetic nerve.

With regard to the fifth nerve, which is that of sensation and nutrition of the eyeball, the irritation of it by a foreign body is of itself quite sufficient to account for the reflex phenomena in the other eye. Claude Bernard, in his demonstration of the action of strychnine on the posterior column of the spinal cord, proved that a sensory nerve may, independently of absorption, convey the irritation to the nerve centre, whence it may be reflected to any other part of the nervous system. After separating the hinder legs from the body of a frog, leaving them attached only by the sciatic nerves, he dipped the legs into a solution of strychnine. The animal did not manifest any signs of the influence of the drug for half an hour; but after that time symptoms of poisoning invaded the whole body. During the period, therefore, which elapsed between the time of the immersion into the poison and the appearance of the toxic effects, there was a period of quiescence, the morbid action going on independently of consciousness.

The phenomena of traumatic tetanus, where a long interval passes between the infliction of the injury and the invasion of the tetanic spasms, point in the same direction, viz. that the sensitive nerves, even in the cerebro-spinal system, have the property of transmitting to the brain sensations which although they escape our cognizance, may play an important part in pathology; for when a nerve has once been put into a pathological condition, this condition is transmissible from the periphery to the centre, and is capable of further generalizing itself.

In the ciliary region the branches which come from the fifth nerve interlace with those which come from the sympathetic, and we must, therefore, regard them both as participating in the lesion, and conveying centripetal morbid sensations, which are ultimately reflected to the other eye. This is all we know of the subject, and we are unable to assign any reason why that morbid sensation should be reflected into the other eye, and not to some other part of the nervous system.

The first manifestation of sympathetic inflammation is indistinctness of vision, then there ensue hyperæmia of the conjunctiva, pericorneal injection, and discolouration of the iris, the uvea beginning to adhere at several points to the lens-capsule; the pupil becomes undilatable, the anterior chamber shallow, and the vitreous cloudy. Ophthalmoscopic examination now becomes impracticable, and by-and-by the lens becomes opaque. Tension of the eyeball may increase at first; but ultimately the eye gets soft and atrophies. Generally very little pain or photophobia accompanies the affection, and the injured eye is blind before the disease is reflected to the other; but in some cases the injured eye may be quiescent, and vision, although lowered, is not completely gone before the other eye becomes implicated. Sometimes there is "herpes frontalis" on the same side as the injured eye.

Treatment.—The phenomena of sympathetic inflammation had long attracted the attention of ophthalmologists before a radical remedy was thought of. First an attempt at treatment was made by iridectomy, then by means of extraction of the lens, but at last it was found that the removal of the injured or diseased eye is absolutely necessary, and Critchett was the first to point out that enucleation, to be satisfactory, must be resorted to before sympathetic inflammation has set in, for, when once present, the removal of the injured eye is of little use, as this very rarely arrests the progress of the disease. It is therefore imperative, in every case of injury, when the injured eye is blind and inflamed, to remove it, in order to avoid the misfortune of this dangerous disease—sympathetic inflammation. It is true that we may thus sacrifice eyes which might perhaps shrink and remain dormant without causing inconvenience, but we escape thereby an alternative risk, which is very serious to contemplate.

In cases where the operation has been delayed, and sympathetic inflammation of the other eye has already set in, we have to face a condition of the gravest import. Ophthalmologists are agreed in looking upon this stage of the disease as all but hopeless, and the propriety of any surgical interference is even called into question. This last is the view which I adopt in most cases, upon the principle that, if surgical interference cannot return sight to either eye, it ought not to be had recourse to. But sometimes we are called upon to operate, either with the view of alleviating suffering, or to give the patient some chance of saving vision, however slight that chance may be.

Case 1.—Some years ago I was asked to see a patient at Stranraer, who had injured one of his eyes with a piece of coal only three weeks before. The injured eye had suppurated, but caused no pain, while the other eye was completely destroyed by sympathetic inflammation, and caused him great suffering. Seeing the hopelessness of his condition, I advised non-interference; but a year later he came to Glasgow, asking me to remove the non-injured eye, which was in a condition of total staphyloma, and had caused him intense suffering during a long period, as was evinced by his emaciated condition. Enucleation in this case relieved the patient of his protracted suffering.

CASE 2.—George G., aged 11, Glasgow. On October 29th, 1874, when assisting a tinsmith at his work he was struck with a piece of iron on the right eye; vision was completely abolished, and pain persisted in that eye in spite of treatment from the time of the accident till the beginning of May, 1875, when he was ordered to the country to recruit his health, which had begun to suffer. In July he returned from the country, when he was again taken under treatment till September 20th, when he first presented himself at the Glasgow Ophthalmic Institution for advice. The boy's face manifested great suffering—there was great photophobia and lachrymation in both eyes; spasms of the orbiculares, so great that it required considerable force to open the eyelids. The injured eye presented a flat cornea, a large central cicatrix, showing the site of entrance; the eyeball was shrunk, and flattened in several places. The non-injured eye did not look more promising: the eyeball was unsteady; the pupil completely occluded by a false membrane; the iris of a dirty greenish colour, and bulging forward; the anterior chamber very nearly obliterated; the ciliary circle constricted and tumefied; vision was entirely abolished. He could see no objects, nor his own fingers. On touching the injured eye through the eyelids, he started as if hurt, and this was repeated several times with the same result. From the violence with which he started at each touch, I had no hesitation in deciding that there was a foreign body still lodged within the eyeball, and advised immediate enucleation. This was accordingly done, and on examining the eyeball after removal I found that the lens had completely disappeared; the vitreous was scanty and full of serosity and clots; and there was a rusty piece of iron, measuring three quarters of an inch in length and one sixteenth of an inch in breadth, grasped by the iris, ciliary processes, and fibrous bands, so firmly that it required to be dissected out from the position where it was embedded. As to the uninjured eye, the distressing conditions above described were not ameliorated by the removal of the offending body.

I performed an iridectomy, from which he benefited, but it was only of short duration.

The tenderness of the eye to the touch, and especially tenderness in the ciliary region of an injured eye, is itself an urgent call for enucleation; and that peculiar start at the touch, as if the person had been pricked, is a symptom of a foreign body lodging in the interior of the eyeball, as certain as if it had been proved by ocular demonstration. There is only one pathological condition caused by injury in which the symptom of starting is present—namely, ossific deposit in the interior of the eyeball, the product of internal ocular hæmorrhage—but it takes several years before the disease is fully developed, and I have never seen it terminate in destructive sympathetic ophthalmia, neither is the starting so violent as in the case of the impaction of foreign bodies in the interior of the eyeball.

Enucleation of the Eyeball

Is performed in the following manner:—The patient being under chloroform, the lids are held open by a speculum, the conjunctiva is seized at the upper part with the forceps, and an incision made; a strabismus hook is then introduced, and the superior rectus muscle cut; then the hook is swept round the globe, from within outwards, and the recti muscles and conjunctiva cut round close to the cornea; the eyeball is dislocated a little inwards; a pair of curved scissors is introduced at the outer angle of the eye, and the optic nerve divided; the eyeball is then lifted out of the orbit, and the oblique muscles are cut off at their insertions.

Bleeding is arrested by the application of dry compresses to the eyelid. Dressing consists of dry lint on the closed eyelids. I never put any stitches into the conjunctiva, but in some cases it might be very desirable to do so.

In enucleating a torn eyeball I put in one or two ligatures to unite the wound, these serving the purpose also of enabling me to put the eyeball on the stretch, and thus facilitating the operation.

LECTURE IX

THE CRYSTALLINE LENS AND ITS CAPSULE

Gentlemen,—The crystalline lens is an object of great interest to the anatomist as well as to the surgeon. It is a circular transparent body, representing the biconvex lens in the dioptric system of the eye, which serves the purpose of bringing luminous rays into a focus upon the retina. By its elasticity the lens is also enabled to add a meniscus to its convex surface, and thus forms part of the mechanism of accommodation, whereby a purely physical act is transformed into a voluntary or reflex vital function. The important and common disease of cataract, to which it is subject, renders its study particularly interesting to the ophthalmic surgeon.

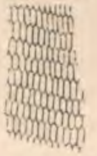
The lens is placed behind the iris, in front of the vitreous body, to which it adheres by its posterior surface, where the vitreous is hollowed out to receive it, and it is fixed to the rest of the eye in front chiefly by the zonula of Zinn or the suspensory ligament (see page 19).

The lens is about one third of an inch wide and one sixth of an inch thick, more convex behind than in front. In early life it is soft and nearly spherical, but grows larger and flatter with age, as well as harder, and somewhat amber coloured. The globular shape of the infant's lens renders the aqueous chamber small, and brings the iris almost in contact with the cornea; but in the adult the iris is rather pushed backwards, and the aqueous chamber is deeper. The axis of the lens, *i. e.* an imaginary straight line drawn from its anterior to its posterior pole, is slightly eccentric towards the nasal side.

The solid transparent mass of lens is soft and pulpy in the outer portions, called the cortical substance, and more firm, dense, and gelatinous toward the centre, which is called the nucleus. There is, however, no plan of division between the cortical and nuclear portion, for the one passes imperceptibly into the other.

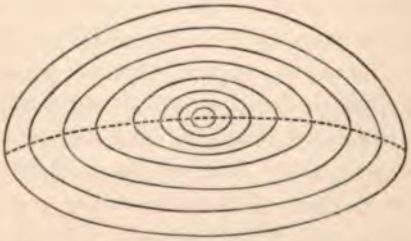
The lens is composed of flattish, ribbon-like fibres or tubes, having an average thickness of $\frac{1}{5000}$th of an inch. Their union is effected by simple apposition, their flat surfaces invariably lying parallel to the surface of the lens, and their attenuated borders looking regularly into each other; in the interior of the lens, therefore as seen in (Fig. 46), every tube is surrounded by six others, and their transverse sections present the appearance of a wall built of six-sided bricks. It is owing to this arrangement that the lens breaks up into lamellæ more readily in the direction of the surface than in that of the thickness. In consideration of this peculiarity we may ascribe a lamellated structure to the lens consisting, like an onion, of a series of lamellæ, one enclosed within the other. Fig. 47 shows the direction of its layers. You must, however, bear in mind that the division into fibres and layers is altogether arbitrary, for the natural connection of the layers and their perfect transparency do not admit of any such division, and the separation into fibres and layers is produced after the lens has been im-

Fig. 46.



Transverse section of the lenticular tubes of man, magnified 350 times, after Kölliker.

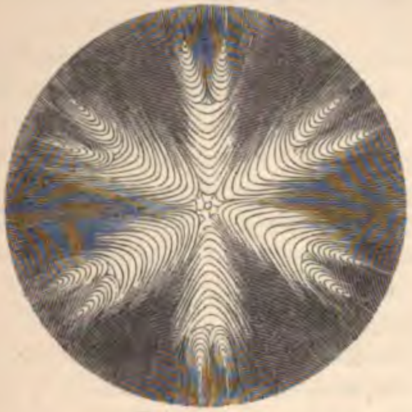
Fig. 47.



mersed in acids or other fluids, when we notice that the direction of the fibres in every layer is generally from the axis of the lens to its periphery, while in the neighbourhood of the axis they curve back, and present a peculiar star-like appearance. Fig. 48 represents the external layer of the lens.

The lens is enclosed in a capsule of perfectly transparent, homogeneous, and very elastic membrane, which envelopes it and separates it from all surroundings, but is very permeable to fluids, and is the medium through which the nutrition of the lens is carried on. The capsule is thicker in front than behind, the diminution in its thickness commencing rather suddenly at the attachment of the zonula, and continuing gradually over the border of the posterior surface, where the minimum thickness is attained. Upon its internal surface, which is applied to the superficial fibres, the anterior capsule has a layer of epithelium, with small, transparent, nucleated pavement cells, which form an organic union between the body of the lens and its capsule, and it is through them that the nutrition of the fibrous part is effected. It is by multiplication and transformation of these cells into fibres that the body of the lens increases in size, and when its growth is complete a single layer of them remains. The superficial fibres, even in the adult, retain some of the nuclei in an extremely transparent form at pretty regular distances in their substance; and these

FIG. 48.



cells, being found only at the inner surface of the anterior capsule and not in the posterior, it is supposed that the nutrition of the lens is carried on with more activity through the aqueous humour than through the vitreous body.

After death the epithelial cells and their nuclei become swollen and soften; and when the capsule is opened, some hours after death, a few drops of fluid are found between it and the lens. This is called *liquor Morgagni*, which is a post-mortem change, the aqueous humour having transuded through the capsule, and in it are found some detached epithelial cells.

The hardening process which the lens undergoes with age begins at the nucleus and advances towards the periphery. At the age of forty or fifty the change may be observed, even with the naked eye, but rendered more distinctly visible by focal illumination. When you throw a pencil of light through the pupil the lens appears as if divided into sectors of a dull grey colour, so that you are apt to mistake it for lenticular opacity; but look upon it through the mirror, and you will see it perfectly transparent. This grey reflection is owing to the fact that the fibres of the nucleus having become harder and less flexible, and the whole lens flatter, the structure of the anterior layer becomes more visible.

These considerations of the organic life and growth of the lens will enable you to appreciate the pathological changes which may take place within its substance or capsule at different periods of life.

CATARACT

The term cataract (*καταῤῥάκτης*, from *καταῤῥάσσειν*, to flow rapidly) was applied to the disease which we have now to consider, from the idea which prevailed among the ancient writers that the blindness was caused by a watery suffusion ("*gutta obscura*") behind the pupil; but, with our present knowledge of its nature, we may define it as a complete or partial opacity of the lens and its capsule.

It is called *lenticular*, *capsular*, or *capsulo-lenticular*, according as the opacity is confined to the lens or capsule alone, or extends to both.

Cause.—Any alteration of or interference with the nutrition of the lens tends to render it opaque. The alteration may be caused either by disease or by injury, or it may be congenital. In this city we see a large number of cases of accidents to the eye, and a classification of the causes of cataract, which will prove clinically useful, will fall into the following three chief divisions, viz.:

a. Cataract caused by malnutrition of the lens.

b. Traumatism of the lens.

c. Congenital cataract.

With regard to the opacity of the lens caused by malnutrition the very nature of the causation must in many cases remain obscure, but we know—

1. That eight ninths of the cases of cataract occur in persons who have passed the age of forty, and by far the largest number of these are above sixty years of age. This leads us to regard it as an expression of senile marasmus, and hence the term *senile cataract.*

2. It is sometimes the accompaniment of diabetes, in which disease sugar is found in the aqueous humour, and it is not unreasonable to suppose that this foreign substance vitiates the nutrition of the lens by its chemical action, or by increasing the density of the aqueous humour, which retards the circulation. Cases have occurred in which incipient diabetic cataracts have been cured or arrested in their development after the sugar had disappeared from the urine, which shows that the opacity of the lens is in direct relation to the sugar in the secretions.

3. Ignatz Meyer has recorded cases which go to prove that ergotism, *i.e.* the consumption of bread containing ergot of rye, predisposes to the development of cataract.

Considering the position of the lens and its dependence for nutritive material upon the neigbouring tissues, it is highly probable that any protracted malnutrition of the tissues analogous to senile marasmus might tend to produce cataract. A considerable number of cases, however, occur in persons in middle life, in perfect health, without any assignable cause, and these we must refer to an inherent tendency. It is worthy of note that this complaint very often runs in families.

Cataract may develop at any age, even during fœtal life. Both total and partial cataracts occur congenitally. When congenital it may be noticed either soon after birth, or not till some months, or even years, later, according to the time which it takes to advance to the anterior layer of the lens. Frequently it is associated with amblyopia. When there is nystagmus, or oscillation of the eyeball, this may be looked upon as an unfavourable symptom. Choroiditis and retinal complications should be suspected along with the opacity.

The division of cataract into (*a*) soft and liquid and (*b*) hard cataract, coincides with the fact that, in children and in persons under thirty years of age, the lens has a tendency to soften and liquefy, and has a milky-white appearance, while at a more advanced age the physiological condition of the lens renders the nucleus more consistent, and hence, after the age of thirty, the cataract is generally hard, *i.e.* the fibres of the nucleus are more dense than the cortical portion. In old people the nucleus becomes not only tougher and harder still, but also changed in colour. Even in cases of senile cataract, in which the cortical layer has become soft or liquid (*cataracta Morgagniana*), there is always a hard, more or less amber-coloured nucleus, which is characteristic of the senile form. This gives rise to the division adopted by some writers into *cortical* and *nuclear* cataract, the former comprising the opacities in which the lens is homogeneous and generally softish throughout, and the latter comprising those in which there is a hard or tough nucleus. In some cases, generally when complicated with choroiditis and soft vitreous, the cataract approaches to a black hue.

Lamellar or *zonular* cataract is an interesting form of partial lens opacity, in which a layer of clouded lens substance is situated between a transparent cortical layer and the transparent nucleus, or, more correctly speaking (as this form occurs in children), between a transparent cortical layer and the place where, in old persons, the nucleus is formed. On dilatation of the pupil there is found a clear transparent zone at the periphery of the lens, through which rays of light reach the retina.

Jaeger, who first described this form of cataract,[1] very appropriately gives it the name of zonular, and explained its origin in the following manner:—"At the early period of life, when the lens is still in process of rapid growth, from some cause or other an opacity forms in the cortical layers, which, however, by the growth of the new lens fibres, gradually are pushed away from the capsule. When the new lens fibres are quite normal the corticalis will be transparent; when they are somewhat diseased it will be clouded."

Zonular cataract generally occurs in both eyes at the same time, and remains absolutely stationary. Arlt and Horner regard it as connected with convulsion and brain disturbance. We have at present (Nov. 6th, 1880) under observation a case bearing on this subject:

Daniel L—, aged 22, clerk, has a congenital absence of both irides, and also partial opacity of both lenses. In the left eye there is a flat lens disc situated at the nucleus, the flat surface of which is looking to the temple with a kind of shoulder presentation to the cornea; the right eye has also a white lenticular speck at the nucleus. According to v. Jaeger's theory the opaque layer must have been pushed in edgeways.

We may notice, in this connection, another irregular form of opacity, viz. *striated* or *punctated* cataract, which is characterised by the development within the lens of a great number of fine points or irregular lines, between which transparent lens substance remains.

These cases generally progress very slowly.

Pyramidal cataract is that form in which the central portion of the opaque lens is elevated like a pyramid, which is situated within the capsule; it may either be congenital or develop during childhood.

I have operated in a case of double senile cataract, in a woman with pyramidal cones in the centre; the capsules were very hard; indeed, after the lenses were removed and vision restored, the white and tough capsules were still visible.

Posterior polar cataract.—Circumscribed opacities of the posterior pole of the lens are always connected with choroiditis, and sometimes also with diseases of the retina. Whenever a case comes before us which shows by focal illumination an opacity situated at the posterior hemisphere of the lens, the rest being transparent, we suspect it as a choroidal cataract. The opacity is limited in extent, has a whitish-grey centre at the posterior pole, from which feathered striæ radiate, and it might be mistaken for an opacity of the posterior capsule, although it is rather of the lens substance. When a cataract of this kind becomes complete, and the surgeon is tempted to extract the lens, the operation will result in disappointment, for there is little chance of sight being found in such an eye. In the various forms of opacity of the lens which I have just enumerated the lens-capsule preserves its normal transparency, and does not participate in the structural change. We have now to consider those forms of cataract in which the capsule is involved, viz.:

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[1] 'Ueber Staar und Staar Operationen,' Wien, 1854, p. 17—22.

Anterior capsular cataract (partial).—When the small anterior cataractous spots involve the lens substance they almost always occur in both eyes congenitally, but more frequently these white spots are situated upon the anterior lens-capsule in consequence of ulcers which cause perforation of the cornea. Arlt's view was that a portion of the exudation from the corneal ulcers remained attached to the capsule; but we find a number of these capsular specks in the centre, even, when the ulcer does not correspond to it, having been at the periphery of the cornea; and in some cases they occur when there has not been corneal ulcer at all.

Mr. Bowman's theory is more satisfactory. He holds that in consequence of the prominence of the lens in infancy it sometimes acquires a minute opacity in the centre or most prominent point of its anterior surface, from coming in contact with the cornea, where this membrane is inflamed, in cases of purulent ophthalmia.[1] This may take place without corneal perforation. In connection with inflammation of the iris I referred to the exudations, which may remain adherent to the anterior surface of the lens-capsule.

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[1] 'Lectures,' p. 62.

The *internal* surface of the capsule sometimes becomes studded with white spots or flakes in cases of over-ripe senile cataract, *i.e.* when left too long without surgical interference. After the most successful extraction the divided capsule has a tendency to unite, forming secondary cataract.

Capsulo-lenticular Cataract.—The most important changes, however, take place upon the internal or epithelial surface of the capsule. In cases of infantile cataract, when the lens is fluid and has shrunk, the capsule is generally opaque and thickened at its inner surface, and it is then found to be tough, so that no impression can be made upon it by the needle. This is a point of great practical importance to bear in mind in operations for cataract. When putting in the needle to open the capsule, if this structure is found to be tough and the lens yielding under the instrument like an imperfectly inflated vesicle, you may be pretty sure that you have to deal with a degenerated lens, and very likely with some serious complications in the structures besides. The same condition of the capsule may be found in cataracts at different periods of life, when they are the result of iritis and cyclitis, or consecutive to some forms of glaucoma. It is also present in an exaggerated form in calcareous cataracts. Indeed, calcification of the lens begins generally at the capsule, the chalky deposits, which consist for the most part of carbonate of lime, take place immediately behind the capsule upon the superficial layer of the lens, whence they progress inwards, so that the entire lens may become calcified to such an extent that it is transformed into a strong concretion, which is enclosed in a thickened capsule. In all these cases, in consequence of the softening of the vitreous, and atrophy and rupture of the zonula, there is in the first stage a tremulous condition of the iris, and subsequently the degenerated lens sinks into the vitreous.

Cataract is said to be *mature* or *complete* when the opacity has extended to the external cortical layer, and *immature* or *incomplete* when part of the cortex is still transparent.

Cataract is called *simple* when all the other eye structures are healthy, and *complicated* when the opacity of the lens is associated with diseases of other structures. Among such complications may be mentioned the following:

1. Opacities of the cornea, synechia, and closed pupil, are complications easily noticed when present. When the old flap extraction was the only method of operation in vogue these complications were considered insuperable barriers to the removal of the opaque lens, but they are no impediments to our new operative procedure.

Among my first patients for cataract in Glasgow, twelve years ago, was Miss S—, of Hellensburgh, a middle-aged lady, who had lost her right and best eye by a flap extraction some years previously. Dr Mackenzie, who was then still adhering to Daviel's operation, considered the other eye, in consequence of these complications, not suitable for interference. I extracted the lens by an upper section, performing iridectomy at the same time; vision was restored, and she is still enjoying perfectly good sight.

2. *Tremulous* iris, indicating softening of the vitreous (synchesis), is another great impediment to flap extraction, but of itself offers no great discouragement to operative interference. We have only to use extra caution and care, and we must plan every step of the operation so as to overcome the risks which that condition involves.

3. It is useless to operate when there is soft vitreous associated with a soft eye, which indicates choroiditis. I need hardly add that, when the eyeball is hard—harder than normal, showing a glaucomatous condition—this is itself a contra-indication to surgical interference.

4. The eye must further be examined, with the view of ascertaining the presence of other possible complications, viz. disease of the retina or of the optic nerve. These are generally ascertained by testing the perception of light of the cataractous eye. For this purpose the patient is put into a dark room, a lamp is held straight before him, and moved quickly in every direction, the patient being instructed to follow with his finger the movements of the flame. If he fails to follow the light in some directions there is reason to fear nervous or retinal complications. It is generally considered that, if the upper or lower half of the field is lost, we should suspect

detachment of the retina, while if the lateral halves are wanting an affection of the optic nerve may be looked for.

In some cases, however, this test is not quite conclusive. Sometime ago we examined a case of senile cataract along with Prof. Hirschberg, in which there was a large, hard nucleus, the cortical layer being softish and considerably swollen, so that dilatation of the pupil was limited, and the field was deficient in some directions. Judging by the above test, we might have considered the case rather doubtful; but as the eye appeared normal in every respect, and the history was satisfactory, I thought the deficiency of perception was owing to the fact that light had to pass through opaque strata of different densities. I extracted the lens and found vision perfect.

Having ascertained that the cataract is simple, the other tissues being healthy or not complicated with any change which might frustrate an operation, we proceed to remove the lens.

OPERATION IN CASES OF SENILE OR HARD CATARACT

The object of this operation is the removal of the opaque crystalline lens from the eye through an opening made in the cornea. There are various methods employed for the achievement of this end. To give a correct view of the whole subject I shall submit a short outline of the history of the operation of extraction, and trace the different stages of its development. It will be interesting to see how we have progressed step by step in our course of improvement, and have been able to turn an operation, which was fraught with anxiety to the surgeon and risk to the patient, into one of comparative ease and security.

The history of extraction of cataract can, according to Rhazes, be traced as far back as the end of the third century, when it was performed by Antyllus, and at a later period by Lathyrion. Ali-Abas, in the tenth century, knew also of the operation; and, later, Abulkasem having found it dangerous, endeavoured to remove the cataract by suction, a method generally adopted by the Persians. But if the operation ever was performed at that remote period it fell into oblivion, and was practically unknown till 1707, when St. Ives made an incision in the cornea, and by means of a curette extracted the cataract, which had passed through the pupil into the anterior chamber. The following year Pourfour de Petit performed the same operation upon a priest in the presence of St. Ives and Mery. The latter submitted an account of the operation to the Académie des Sciences,[1] in which he proposed to extract the cataract through a corneal incision, not only when dislocated into the anterior chamber, but also when lying *in sitû* behind the iris. As the author, however, never performed the operation which he so ingeniously suggested, his proposal was fruitless, and nothing further was made known on the subject until the hint was reduced to practice, and the whole particulars of the process published by Daviel, a French surgeon, in 1745.[2] To Daviel, therefore, belongs the credit of having obtained that new conquest to science in systematizing the process of extraction of the crystalline lens through an incision in the cornea.

Daviel's process was subsequently modified by La Faye, Wenzel, Richter, Barthe, and Beer, the modifications referring partly to the size and direction of the flap, and partly to the form of the various instruments used.

DAVIEL'S METHOD OR FLAP EXTRACTION

This operation consists in the removal of the crystalline lens through the pupil and through a semicircular opening made in the cornea, either in its upper or in its lower half. The incision must be made large enough to allow easy exit to the lens without the use of much pressure, which would otherwise do violence to the iris, or rupture the hyaloid membrane, and force out the vitreous humour. The size must be regulated by the nature and density of the cataract. If there is a large, hard nucleus, the section should commence at the transverse diameter of the cornea, the twentieth of an inch from its junction with the sclerotic, thus opening the half of its circumference; but when the cataract is of a homogeneous and softish consistency, or with a small nucleus, a section of five twelfths of the circumference is sufficient, as such a cataract can mould itself and pass through a smaller opening. Mackenzie advises us to make the incision "at least one half the circumference of the cornea," and mentions Ware as proposing a nine sixteenth part.[1] After the incision is made, the anterior hemisphere of the capsule is to be lacerated as widely as possible with the cystotome, and the lens to be partly squeezed out through the opening.

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[1] 'Mémoires de l'Académie des Sciences,' 1708, p. 310.

[2] Daviel: "Sur une nouvelle méthode de guerir la Cataracte par l'extraction du crystallin," 'Mémoire de l'Académie de Chirurgie,' T. ii, p. 336, 4th edition, 1753.

When this operation is well performed, and the healing process proceeds regularly, it leaves nothing to be desired. It is so beautiful in its results and appearance that it may be called the *chef d'œuvre* of ophthalmic surgery.

So high was my appreciation of this method that in 1864, when exhibiting to the Aberdeen Medico-Chirurgical Society four of the first cases operated on by my improved method, I stated that I "still adhere to the old classic operation, but cases do occur, which are associated with local or constitutional complications, rendering the old method either too hazardous or impossible. To overcome such difficulties we must devise new plans for the removal of the opaque lens."[2]

It must, however, be admitted that, besides the inapplicability of the flap operation to some cases, it carries a number of unfortunate contingencies in its train. Not to mention the accidents which may occur during the operation, but which may be overcome by dexterity and judgment, there are others beyond the control of the operator which may undo his best executed work. It is evident that ordinary flap extraction is inapplicable to a cataractous eye complicated with—

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[1] 'Practical Treatise on Diseases of the Eye,' p. 788.

[2] 'The Lancet,' April, 1868.

(1) An adherent pupil with or without pseudo-membranous exudations.

(2) Confluence of the vitreous humour (synchesis).

(3) Dropsy of the anterior chamber (hydrophthalmos).

(4) Central opacity of the cornea.

Moreover, as the patient is required after such an operation to remain perfectly quiescent for about six or eight days or longer, it is impracticable in the case of those who are suffering from disease of the bladder, bronchitis, sciatica, or other infirmities incidental to old age. Every ophthalmic surgeon who practises this operation will be able to supply instances from his own experience, where a fit of coughing or sneezing, straining or starting, some days after the operation, marred his brightest prospects.

Let us briefly analyse the principal factors which render the operation *per se* hazardous.

A. The large *corneal* incision requires some days before it heals, and a few additional days before the cicatrix is beyond the risk of being burst open. Now, in a patient of weakly habits, such a large flap is apt to suppurate, independently of the contingencies of malcoaptation, although in my experience primary suppuration of the cornea is very rare indeed.

B. The *lens* may be found unnaturally adhering to the capsule—one of those cataracts which come slowly to maturity—and, instead of coming out entire, the nucleus alone comes away, leaving the cortical substance in the equator of the eye, and no coaxing can entirely remove it. The fragments which remain within the interstices of the capsule may cause proliferation of the epithelial cells and those of the membrane of Descemet, and thus act as a focus of inflammation.

C. The *iris* is the most fruitful source of subsequent mischief. The sphincter iridis sometimes contracts so much that the capsule cannot be sufficiently opened, or, even after it has been opened, the iris may close upon the lens, preventing its easy exit; excessive pressure is used, and contusion is the result. Now, if this membrane has been wounded by the knife or lacerated by the cystotome, and particularly if it has been contused by undue pressure during the accouchement of the lens a form of iritis develops itself, which may either close the pupil, or the inflammatory process may extend to the wound, causing the latter to burst, and so produce hernia iridis and anterior adhesion, or it may even extend to the ciliary circle and to the deep membranes, causing panophthalmitis and complete destruction of the eyeball.

With so much anxiety did our classic writers caution us against the lesion of the iris, which they regarded as the starting-point of nearly all the ills that befall the eye after extraction of the lens, that Makenzie's advice is, in any case where "the iris has fallen under the edge of the knife, an attempt must be made to push it back by pressing with the point of the finger on the cornea; but if the iris do not retire on pressure on the cornea the knife must be withdrawn, and *either the operation deferred* to another day, or a small probe-pointed knife introduced through the aperture which has been made, pushed gently through the anterior aperture to the nasal edge of the cornea, and over the end of it an opening made with another knife, so as to allow it to come through, after which the incision is to be finished exactly in the same way as if the sharp-pointed knife only had been employed."

Desmarres was the first to advise us that when a fold of the iris has fallen upon the knife it is better to run the knife through it, for although in cases of contusion or laceration you may expect some mischief, yet when a slice of the iris has been cleanly cut off, the healing process is far easier, and no iritis need be apprehended.

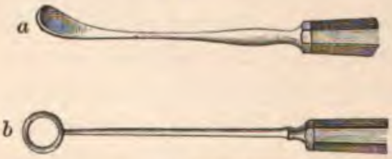
This doctrine seems to me to contain the germ of the improvements which of late years have been introduced into ophthalmic operations.

The introduction of iridectomy for the cure of irido-choroiditis and glaucoma by von Graefe had the effect of familiarizing us with the operation, and of extending its application to the extraction of cataract. The practice of combining the operation of extraction with that of iridectomy, performed either at the same sitting or at a previous period, had already been adopted by Desmarres in 1856, in cases which were complicated with posterior adhesions. Von Graefe practised it also in some cases of soft cataract. But whilst these eminent operators regarded it only as a means to be resorted to in complicated cases, and while Desmarres, in his subsequent writings[1] considered the integrity of the pupil as an essential point, Waldau published a paper in 1860,[2] proposing its general adoption.

WALDAU'S SCOOP OPERATION

This consists in the removal of the cataract through a small corneal incision, extending through less than a quarter of its circumference, and a coloboma iridis, aided by a spoon which he devised for the purpose. Mr Bowman and Mr Critchett, who introduced it into this country, have modified the instrument and the procedure, and the instrument has been still further modified by Dr Taylor of Nottingham.

FIG. 49.



Represents the instruments: *a*, Critchett's; *b*, Taylor's modification.

It was found, however, that it was one thing to seize a lens with a spoon, but another to extract it safely and entirely through a narrow outlet, without damaging the internal membranes or lacerating the cornea, and hence the *traction* method has fallen into disrepute.

Whatever may be the drawbacks of Waldau's method, he certainly is entitled to the credit, not only of having enriched us with an instrument which renders us services in emergencies, but also of having been the first to popularize the procedure, based upon the principle of sacrificing a portion of the iris for the sake of lessening the risk of a hazardous operation.

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[1] 'Clinique Europeenne,' 1859.

[2] 'Die Auslöpfelung des Staares,' Berlin.

MOOREN'S METHOD

In 1862 Mooren proposed, with the view of lessening the danger of corneal suppuration, to perform iridectomy two or three weeks before the removal of the lens;[1] and, therefore, his method resolves itself into the ordinary flap operation with an iridectomy in advance.

From the causes of failure which attend Daviel's method, and which have just been mentioned, we cannot but regard this operation as a step in the right direction. The coloboma iridis, made at a previous period, allows free issue to the cataract and lessens, *pro tanto*, the risk; but there still remain the contingencies connected with a large flap.

JACOBSON'S METHOD

Jacobson made the ordinary flap at the corneo-scleral junction, and excised a large segment of the iris either before or after removal of the lens. This, owing to the peripheric incision, enhances the risk of losing some of the vitreous, and, therefore, this operation has found no imitators.

You will thus see that from 1745 till 1860 the extraction of an opaque lens from the eye was effected by Daviel's method, and that, although this was considered the only operation worthy of being employed, there was a general feeling afloat with regard to it that the immediate and subsequent risks were very considerable. The existence of such a feeling is shown by the eagerness with which Waldau's spoon operation was received. The spoon, however, proved a clumsy contrivance, and fell into disuse, to be speedily followed by a host of innovations in other directions.

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[1] 'Die verminderte Gefahren des Staar-extraction,' Berlin.

On the almost general abandonment of the old operation there ensued a period of anarchy, or rather a veritable republic, in which every man was his own authority, and operated on cataract according to his own ideas. And this state of matters I consider, is not at all to be regretted, but rather necessary to the building up of a new system, free from dogmatism, by means of contributions from many fellow-workers.

LECTURE X

VON GRAEFE'S MODIFIED LINEAR EXTRACTION

GENTLEMEN,—Of all the new operations for the extraction of the lens none has attained such a position as that introduced by von Graefe in 1865, under the name of "modified linear extraction," in which he substituted a small linear incision for the "flap."

Von Graefe's procedure is as follows:

1. The patient being placed in a recumbent position, and the eyelids separated by a speculum, the surgeon stands by the side of the patient when operating on the left eye, and behind him when operating on the right. With the forceps held in the left hand, the lower part of the conjunctiva is seized at the insertion of the tendon of the rectus inferioris, and with the right hand the upper section is made by introducing the narrow knife (Fig. 50), entering it at the extreme periphery of the anterior chamber. The operator first directs the point of the knife downwards, as if wishing to reach C in Fig. 51; but, after penetrating about three lines in this direction, he lowers the handle, so as to carry the point horizontally to reach the counter-puncture B; then he makes two or three sawing

FIG. 50.

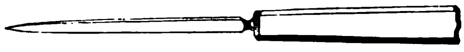
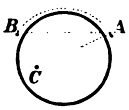


FIG. 51.



motions to complete the section of the sclerotic. This being done, and the knife being still under the conjunctiva, he directs the edge forwards, so as to cut it about two lines from the cornea. He then obtains a section approaching to a straight line, which closes without any tendency to gaping. The dotted lines in Fig. 51 show the direction of the knife and the extent of the incision.

The object of introducing the knife in a downward direction is to enlarge the internal opening, and so to avoid the small shelf or corner at the commencement of the wound, which is necessarily left when the knife is carried through in a horizontal direction, and which presents an obstacle to the passage of the lens.

2. The fixation forceps being then given to an assistant, the surgeon raises the conjunctival covering with small forceps, and reflects it upon the cornea, whereby the iris remains exposed; with the same forceps he seizes the prolapsed iris in the middle and excises it.

3. He now takes the forceps from the assistant into his own left hand, and with the right opens the capsule by means of the cystotome. When the cataract is soft, gentle pressure with the flat end of the curette upon the sclerotic lip of the wound, and counter-pressure with the fixation forceps, are generally sufficient to cause its expulsion; but when the cataract is hard, he introduces a small hook flatly behind the lens, then he turns the hook upon it, and so draws it out. In his later writings v. Graefe improved upon this last stage of the operation. Not trusting it to the *vis expellens* of the forceps, he applies the forceps about two lines towards the nasal side of the conjunctiva, so as to be out of the way, and with the back of a smooth spoon made of caoutchouc, he first presses upon the lower margin of the cornea, and then gradually slides the spoon upwards, whilst no counter-pressure is applied to the upper part. When the cataract is advancing the back of the spoon is pressed more strongly upwards, until it has reached the centre of the cornea, thus chasing the cataract towards and through the wound.

4. When cortical *débris* has remained behind, as happens in the majority of cases, he waits a little until the aqueous humour

has collected, when he makes an attempt to dislodge the remainder of the lens substance towards the wound by gentle circular friction through the closed eyelids; then opening the eyelids, the fragments are either removed by gentle sliding pressure or, if this be insufficient, by means of a small spoon introduced into the anterior chamber.

He avoids the use of chloroform as in general disadvantageous, and, therefore, administers it only to very timid patients.

The principal accident in this operation is the loss of the vitreous. This accident may happen immediately after the section, by the incision being carried so far back that the zonula is left unsupported, and so may arch forward and burst; or by the point of the scissors touching the zonula in excising the iris; or it may be caused by strong backward pressure of the cystotome upon the hard cataract, or by too firm pressure in attempting to expel the lens; while other causes may be found in spasm of the orbicularis muscle, or a pre-existing diseased condition of the zonula.

That v. Graefe's extreme peripheral section exposes the eye to the risk of loss of vitreous is sufficiently apparent from the fact that Arlt and others have modified it by making the section terminate in the corneal substance; this, of course, lessens the outlet, and the section will have to be carried further downwards, thus approaching more to a small flap.

It appears to me, therefore, that v. Graefe did not succeed in the attempt, which he proposed to himself, to steer clear of the Scylla of contusing the internal parts by passing a hard cataract through a small incision, without falling into the Charybdis of carrying the incision so far back as to endanger the vitreous. Loss of vitreous, in itself, is of no great consequence, but such an accident, when occurring before the exit of the lens, is highly embarrassing. It is very natural, however, that any operation associated with v. Graefe's name should command high respect, as he is, undoubtedly, the central figure among modern ophthalmologists.

At the Ophthalmological Congress in Paris in 1867, while listening to the interesting communication by Otto Becker[1] of

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[1] 'Comptes Rendu.'

270 operations in the Vienna Clinique by Arlt and himself, and weighing all the arguments in favour of v. Graefe's operation, I was not induced to adopt it. The results of this method, indeed, in the hands of eminent German and American surgeons, have since proved unsatisfactory, for it is alleged to have introduced a new chapter of accidents, such as sympathetic inflammation through invagination of the iris;[1] and hence it has been so variously modified by v. Graefe's own pupils and followers, that Warlomont's prediction has been almost literally fulfilled, "that of v. Graefe's operation for cataract nothing but the knife would remain."

Speaking for myself, I found his knife an excellent instrument for corneal action.

THE AUTHOR'S METHOD

Since the autumn of 1864 I have practised an operation which, I think, combines the advantages of all recent improvements without their risks.

My object is to remove the cataract through an incision sufficiently large to give free exit to the entire lens, of whatever size and consistency, without bruising the internal parts or the corneal wound, and without incurring any loss of vitreous, and, at the same time, to ensure rapid union, so as to make it applicable to all possible local and constitutional complications. Easy exit of the entire lens, and sparing the vitreous, I consider the essential elements of perfect extraction—perfect both in its immediate and in its prospective results.

In 1868 I published some papers[2] on this subject, giving the results of 107 operations. I have since then tried to improve upon the method there described, profiting not only from the experience of my own practice, but also from close observation and personal inspection of the work of eminent operators in this country and on the Continent.

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[1] The first case was published by Dr. Agnew, of New York, in the 'Transactions of the American Ophthalmological Society.' Dr. Webster has more recently (1880) rendered good service by publishing a whole list of such unfortunate cases.

[2] 'The Lancet,' vol. 1.

The problem which I proposed to myself to solve was how to obviate the risk of failure in operations for cataract? The merit of every new procedure recommended to the profession may, I think, fairly be tested by its fulfilment of this condition: Does it lessen the risk? When we look to the tissues concerned we are struck with the fact that, when fairly dealt with, they are very favourable for a successful result, and we have further the advantage that, we do not work in the dark, so that cataract operations, though the most delicate, are among the safest of the important operations in surgery, if we only consider the risks, and study how to avoid them.

What are the risks attending an operation for cataract?

1. As regards the *cornea*, any rough usage or laceration during the exit of the lens, or neglect to remove shreds of capsule, &c., from the lips of the wound, may be followed by suppuration, otherwise the cornea enjoys great immunity from taking an inflammatory action.

Fifteen years ago I operated on an old lady approaching eighty years of age by Daviel's method; the corneal wound healed as well as could be desired, and the case went on satisfactorily, although I noticed at the time that all the tissues were in a state of marasmus; indeed, a fortnight after the patient went home, this condition made its appearance in the shape of gangrene of the toe, and she ultimately succumbed to it. This case impressed me very strongly with the great vitality of the cornea, and my subsequent study of transplantation has only confirmed me in the conviction that, with fair treatment, we have little to fear from the cornea in operations for cataract.

2. *The iris.*—Any bruising or tearing of this membrane during the operation, or its subsequent prolapse from coughing or restlessness of the patient, may bring on iritis and total disorganisation of the eye.

3. The *vitreous* runs a risk of being lost, either before or during the opening of the capsule, or in attempting to remove the lens.

4. The *lens* may sink into the vitreous, or it may bruise the iris or lacerate the cornea in its exit.

But the most important source of danger is the retention of the cortical *débris*, which may give rise to iritis, extending to the deep structures, and ending in panophthalmitis and collapse. Indeed, so thoroughly am I impressed with the fact that most eyes whose loss is ascribed to cold, restlessness, and other agencies, are really lost from this cause, that I have laid it down as a principle that, whenever excessive pressure is used for the *accouchement* of the lens we are never sure that the operation is safely accomplished. It may be finished as far as the surgeon is concerned, but a few days afterwards, generally about the fourth, the existence of *débris* will betray itself by nocturnal supraorbital pain, choroiditis, &c., ending in partial or complete failure.

Every step of the operation should be planned so as to avoid these complications, but as the parts concerned vary in size, consistence, and firmness, no dogmatic rule can be laid down to answer every case, and the only safety lies in adapting the incision and directing every step of the operation to meet the circumstances of each case. The corneal incision should be regulated, so as to allow of free and entire evacuation of the lens by gentle pressure, and at the same time to secure perfect coaptation of the cut surfaces. Iridectomy should be performed so as not to allow any margin of the iris to be insinuated into the wound, and prolapse of the vitreous should be carefully guarded against at every stage of the operation.

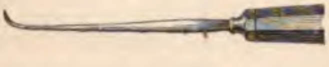
1. I make an iridectomy generally downwards, from two to three weeks prior to extraction. In a case of urgency there need only be an interval of a few days between the iridectomy and extraction, as the two incisions do not interfere with each other. The section of the iris is made subconjunctivally, as shown in Fig. 41, only it must be made with the broader lance (Fig. 45) exactly in the vertical meridian, so as to allow the lens to pass through the centre. Should the iris not prolapse on the withdrawal of the instrument it is drawn out with Tyrrell's hook, and its internal circular border is laid hold of with a pair of iris forceps, and rounded off with scissors in such a way as to imitate the natural pupil (see "Artificial Pupil," p. 119), and leave the ciliary border untouched.

2. In the operation for extraction, the patient being in a recumbent position, I introduce a speculum, and fix the eyeball

by means of forceps tipped with vulcanite, and with Graefe's knife enter the external margin of the cornea close to its scleral junction. The counter-puncture is made directly opposite at the inner side, the point being so chosen that the corneal flap extends—as far as such an operation can be managed with mathematical precision—a millimètre more than the third of its circumference. The knife is then pushed in on a plane parallel to the iris. When the corneal section is nearly completed I withdraw the knife, and, in doing so, direct its point to the capsule, which I open widely. The speculum is then removed.

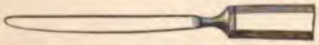
3. Using my thumb and index finger as a speculum, I introduce the cystotome (Fig. 51), and make sure that the capsule is properly opened; and in case of soft vitreous, when the lens has a tendency to sink, I make gentle pressure upon the eyeball, and, using the cystotome as a crochet, bring the lens forward, and put it in a position facing the corneal wound.

FIG. 51.



4. I introduce my small blunt-pointed corneal knife (Fig. 52) with a convex edge, and with it divide the corneal bridge.

FIG. 52.

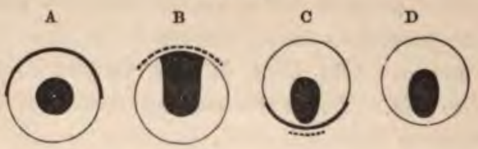


Corneal knife used to divide the bridge.

5. After some seconds of rest I seize a fold of the upper eyelid between my fingers, and depress the lower lid with my other hand; then, directing the patient to look straight forward, I exercise pressure upon the lower part, exactly in the vertical meridian, facing the middle of the iris section, and with the other fingers, holding the eyelids, I press upon the wound to make it gape, when the lens advances to the corneal incision. Any *débris* remaining behind is easily extruded by gentle

manipulation. Fig. 53 shows the size and position of the incision in Daviel's, v. Graefe's, and in the author's method.

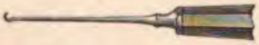
FIG. 53.



Position of the incision, and appearance of the pupil in Daviel's, Graefe's, and the author's methods—A, in Daviel's ; B, in Graefe's ; C and D, in the author's. In C the dotted line shows the sub-conjunctival iridectomy puncture, the black line at the lower periphery, the extent of the incision

When the vitreous is soft I leave a larger corneal bridge, and, instead of finishing the circle at the corneal margin, I carry it more forward into the corneal substance, so as to protect the vitreous from prolapsing. But when the vitreous is too soft, so that the lens cannot be prevented from sinking, the lid is kept closed for a few minutes and gentle pressure applied, the lids are then opened and the spoon (Fig. 49) or hook (Fig. 54) is introduced behind the lens, which is then quickly removed.

FIG. 54.



I refrain from using chloroform, which is unnecessary and tending to complicate matters; neither do I dilate the pupil previous to extraction, in order to avoid the risk of a part of the iris falling upon the knife.

The advantages which I claim for this method are the following :

a. We can shape the iris section with precision, so as to secure a nice appearance, which can only occasionally be accomplished after the cornea has been incised for the removal of the lens.

b. We secure the same acuity of vision as when the pupil is intact.

c. The edges of the pupil are rounded off in such a manner as to prevent them from being invaginated in the wound, and so giving rise to sympathetic ophthalmia, which has been laid to the charge of v. Graefe's operation.

d. The vitreous is prevented from being lost, either at the termination of the corneal section or at the opening of the capsule, by leaving the corneal bridge.

e. The process of extraction is not obscured by bleeding, which sometimes takes place when the iridectomy immediately precedes the extraction.

These are not abstract speculations, but real dangers to be guarded against, for when, after iridectomy, the anterior chamber is filled with blood which cannot be got rid of, the lens must be extracted in the dark, part of it coming away and the remainder making a mass with the coagulated blood. At other times, again, when pressure is made upon the eyeball with the spoon, the nucleus is squeezed out but the cortical remains behind, and will not yield to pressure. The issue of such cases can hardly be doubted.

f. The cortical *débris* can be carefully removed after the extraction of the nucleus.

FIG. 55.

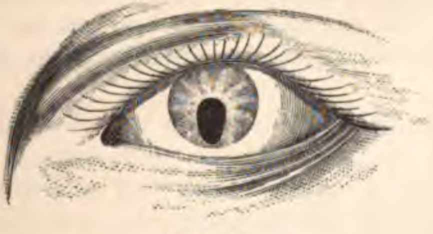
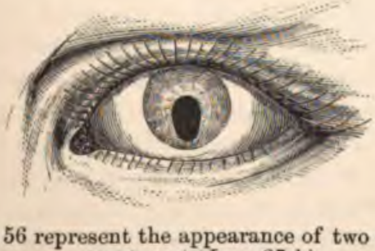


FIG. 56.



FIGS. 55 and 56 represent the appearance of two eyes now under treatment (June 27th).

Although the operation was originally proposed only for complicated cases, the result proved so satisfactory that I never resort to any other method for the removal of senile cataract.

In recommending this operation, I need hardly say that the operative procedure must be adapted to the varying conditions of each case; but the leading principles, when strictly followed out, I consider a safeguard against the risks which render cataract operations precarious. I make a point of testing the result of the operation, and, therefore, allow the patient to count fingers and to recognise friends, &c., before closing the eye, as this always has a soothing effect upon his feelings, and reconciles him to the darkness and confinement, which might otherwise have a depressing effect on the nervous system.

Dressing consists of three strips of court plaster and two plies of lint to both eyes, with a fixed bandage. The patient is kept in bed with the window curtains drawn, and the room darkened; perfect quietness is maintained for two days, and soft food, which does not require mastication, is ordered. On the third day he is allowed to sit up for a little; on the fourth day the eyelids are opened, and he is allowed to look about, after which they are closed again with court plaster. On the fifth or the sixth day he is allowed to get out of bed. We generally dismiss patients from the tenth to the fourteenth day.

It is always advisable to visit the patient on the evening of the day on which the operation is performed.

During the first six hours there may be a gritty feeling in the eye, or now and then shooting pain, or flashes of light may pass across the field. These symptoms are owing to the friction of the wound against the eyelid, and will soon cease. Should there set in any shooting pain, if it is only transitory, and recurring at long intervals, the patient may be told to keep his mind at ease, and remain in a state of perfect quiescence as if asleep, which will generally cause this feeling to disappear; but if it continue, the dressings must be removed and examined, to see whether the bandage is carefully applied, and lint dipped in warm water gently placed upon the lid for a few minutes, and then the dressings reapplied, great care being taken that the lint is free from creases, and that the bandage does not press tightly on the eyeball.

Should symptoms of iritis set in, the eyelids must be opened, and the condition carefully examined. It will very likely be found that the *débris* of the lens is causing irritation, in which case some atropine drops must be put upon the inner canthus, and the lid opened, so that they may find their way into the conjunctival sac; fomentations being of great advantage also. Or the mischief may be owing to derangement of the alimentary canal, caused by confinement, and then the administration of a laxative is all that is required.

CASE.—Mrs. S—, age 64, Dundee, had a successful operation for extraction of cataract performed on the right eye in 1879. She came back in September, 1880, to have the other eye operated on; the lens was removed, and there was no reason to expect any other than a favourable course. On the fourth day, however, she complained of violent throbbing pain in the eyeball, which atropine and warm fomentations did not allay; the upper eyelid became tumefied and glistening; indeed, it was one of those cases in which the application of leeches to the temple is indicated. She was ordered a dose of Oleum Ricini in warm milk, which at once allayed the unpleasant symptoms, and no more complaint was made about her eye. She made a good recovery, and was sent home on the fourteenth day after the operation with good sight.

I generally order patients spectacles for walking and seeing distant objects about a month after extraction, and for reading about a month later. Exposure to wind and cold must be strictly avoided.

The question as to whether one eye should be operated on while the patient is still able to see with the other must be decided according to circumstances. Formerly it used to be the established rule never to operate on one eye so long as the patient was still able to walk about, and to see the difference between a knife and a fork; but while that was a judicious course when the patient had to be subjected to a precarious operation, with our present procedure, when we need hardly expect anything else than a favourable issue, we act upon the following rules:—We never operate upon one eye when the other eye does not show any signs of lenticular opacity, except in young people. In persons advanced in life it is of no use operating on one eye when the other may perhaps never become affected; but when the cataract is complete in one eye, and has to some extent advanced in the other, everything being favourable, I recommend an operation, for it saves the patient the constant worry of looking forward to a dark future, and makes him independent of the other eye when the cataract in it becomes complete. There is, besides, the consideration that with advancing age new diseases and infirmities may be developed, rendering an operation less convenient.

I am generally asked, when one lens has been successfully extracted, whether I would advise the other eye to be operated on. When vision of the one eye is perfectly good, and the patient is upwards of seventy years of age, I do not recommend an operation unless the patient be very anxious himself that it should be performed; but if the sight of the other be imperfect, an operation is certainly to be recommended.

I may say that, as a rule, we have the satisfaction of finding that most of our patients who have had a cataract removed from one eye come back to have the other eye operated on, showing that they are well aware of the advantages and benefits of the restored vision, and that they have no unpleasant reminiscences of the operation and after-treatment which they have been subjected to.

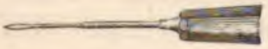
SECONDARY CATARACT

I have already mentioned that, in cases of over-ripe cataract, there is a tendency to thickening of the capsule, and that, although the lens had been entirely removed, the lacerated capsule may reunite and form a secondary cataract. This may, however, take place independently of over-ripeness. A thin membrane may form in front of the pupil, sometimes a year or more after extraction of the lens, and may be so thin and transparent as to be invisible to the naked eye, we may even see the retinal vessels through it with the ophthalmoscope, but it can be detected by focal illumination. The patient can see sufficiently well to enable him to walk about fairly, for he can see large objects, although he has become unable to read small type, which he could do with ease after the operation.

This membrane may be formed either behind the iris, leaving the pupil quite free to act, or it may stretch across the pupil, and thus render it immovable. Should such a membrane be formed shortly after the extraction of the lens it must not be touched till about three months later, when it may be got rid of in the following manner:

The patient being in a recumbent position, the pupil dilated with atropine, the eyelids held open by a speculum, and the eyeball fixed with forceps, a stop-needle is introduced into the cornea (Fig. 57) at its margin on the temporal side, and the membrane torn across in several places without the needle disturbing the vitreous.

FIG. 57.

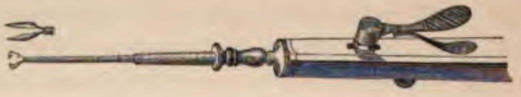


I generally hold another needle in readiness, and in case the membrane be found tough, so that no impression can be made upon it, I put aside the forceps, and, taking this second needle into the left hand, introduce it at the nasal margin of the cornea, and work with both needles at the same time, so as to completely lacerate it. The eye is kept closed for a day or two, and the free use of it is gradually resumed.

I would call your attention to the thickness of the needle, because those which we generally find in the instrument maker's shop are too thick, and cannot be introduced into the cornea without leaving at the point of entrance an opaque spot, which in itself is highly objectionable; but when we have to deal with an eye which has already undergone an operation the introduction of such a clumsy instrument may do further harm. The needle should be as thin as is compatible with the requisite strength.

In some cases in which the membrane is so tough that the needle makes no impression upon it, we use Desmarres' canula forceps (Fig. 58). This is also provided with a pair of minute scissors, by means of which the membrane is cut and then removed with the forceps.

FIG. 58.



In bringing to a close my remarks on the extraction of the lens and the subsequent complications, I cannot omit to mention another troublesome condition which may sometimes occur. I refer, namely, to the inversion of the lids, more especially in the case of old people. Owing to the relaxation of the skin and the closure of the eyelids for several days, entropion may take place and become annoying to the patient. The following are the details of a case which I had lately under treatment, and which presented several interesting features :

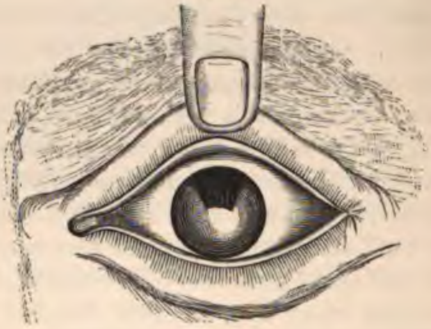
CASE 1.—In August, 1880, I was consulted by Dr. Madden, of Torquay, about the case of a lady, aged eighty years, who had had cataract matured in one eye for upwards of five years, whilst the other was serviceable till about a fortnight prior to the consultation. At this time she had just recovered from severe inflammation of the liver and base of the lung, in which illness her life was despaired of. When she found that her sight was gone, her mind became very much affected; and, contrary to the advice of her medical attendants, who informed her that she was not then in a fit condition to undergo an operation for cataract, she would brook no delay, and insisted that she must have her sight restored at once. I consented to perform the operation, thinking that the preparatory iridectomy performed upon both eyes might give her breathing time to recover her strength a little; but on its being explained to me that the disappointment, after iridectomy, on finding that sight was not restored might have a bad effect, which no explanation on our part could remove, I extracted the lens at once from the one eye, and at the same time made a preparatory iridectomy on the other. The sight was restored immediately after the operation, and the patient's mind was set at rest. The eye was opened on the sixth day. The bandage was kept on for another week, being only removed, morning and evening, for the sake of fomentation; everything was going on quite satisfactorily; but a fortnight later I was asked to see the patient, as her eye continued painful, and occasionally much irritated. The long continued application of the bandage had produced an inversion of the eyelid, causing some annoyance. The bandage was discontinued, a shade was worn, and the eye recovered very soon. She could read small print with cataract glasses for about a month, but after that time had elapsed her sight for reading was diminishing. On examination, however, I was able to assure her that nothing serious had taken place; that only a thin membrane, like a spider's web, had formed in the area of the pupil, and that a slight touch would restore the former acuteness of vision. I asked her, however, not to press me to do it immediately, but to wait for a little, as I was unwilling to touch her eye until six months after the first operation. As a reward for her patience I promised to extract, at the same time, the lens from the other eye. I thus induced her to wait patiently till the beginning of the year (1881), when I lacerated the membrane in the one eye and extracted the lens from the other.

Bearing in mind the tendency to entropion, I opened the eyes on the fourth day, when I permitted her to leave her bed; and, notwithstanding an attack of liver complaint the day after the operation, everything went on well until eight days later, when the eyelid of the eye, on which I had recently operated for extraction, very strongly turned in. This time manipulation was of no avail; indeed, the spasmodic contraction of the orbicularis rendered the opening of the lids impossible on the part of the patient, and, when forcibly opened, the ball instinctively was hid under the upper lid. In this emergency I resorted to the application of serres-fins, which are generally sufficient. I applied three to a fold of skin of the inverted lid, and left them on for a night. The beneficial effect, however, proved only temporary. Two days later the eyelid began again to turn in, but after this we succeeded in keeping it down by court plaster for several days. The subsequent progress was uninterrupted, and acute vision in both eyes was restored.

The following case will show you how we must act when there are present complications in the condition of the lens as well as in that of the cornea.

Case 2.—Mrs. G—, aged 54, Crieff, had lost the sight of her right eye completely by smallpox some years ago. The left eye (as represented in Fig. 3), although vision was not gone, was affected with staphyloma; nearly one half of the cornea was opaque; the iris was adherent in the corneal cicatrix, and not dilatable. Recently this eye became affected with cataract, but without absolutely complete loss of vision. It was one of those cataracts which come slowly to maturity. I first performed iredectomy, and a fortnight later I opened the capsule with a needle without disturbing the lens, and at the same time breaking up old adhesions. Three weeks later, I extracted the lens by a small cornea-conjunctival flap; the result was good sight.

Fig 59.



I shall only direct your attention to the patient at present (July 14th, 1881) in our hospital.

Case 3.—Peter L—, furnaceman, aged 53, lost left eye by an operation for cataract elsewhere, and came to have the cataract removed from the right eye. Patient was admitted three times last winter, but no operation was considered safe in his case, because after two days remaining in the house, waiting to be operated on, he suffered each time from an attack of œdematous, erysipelas of the face, eyelids, &c. The swelling was excessive, and pitted on pressure. He was admitted again July 1st; his face is vascular, and feels hard like leather to the touch. I removed the cataract last week after which he had an attack of œdema of the lids; the swelling was relieved by the application of camphorated spirit.[1] Now, after the swelling has disappeared, you can satisfy yourselves of the success of the operation, which has not been prejudiced by the erysipelatous attack.

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[1] ℞ Camphoræ ℥ss;
Spt. vini rect. ad ℥j. Solve.

Paint over the part. The evaporation of the spirit leaves a coating of camphor. Cover with dry lint, and bandage.

LECTURE XI

OPERATION IN CASES OF SOFT OR FLUID CATARACT

Division or Solution

Gentlemen,—Cataract occurring in children or in persons up to twenty or twenty-five years of age is generally removed by division or solution in the following manner:—The pupil having been dilated with atropine, the patient placed in a recumbent position, the eyelids held open by a speculum, and the eyeball fixed with forceps—

1. A fine needle (Fig. 57) is introduced through the cornea at its margin, and pushed towards the lens, and the capsule opened at the centre.

2. If the cataract is found to be soft the whole anterior surface of the lens may be broken up at once, so as to permit the aqueous humour to come in contact with the entire lens-substance, and allow it to be gradually absorbed. In about three months such a cataract will have disappeared.

3. If, however, the lens be more consistent, laceration of the capsule is limited to the centre, in order to allow absorption to take place gradually, for there is a danger that dislocated fragments of the lens may cause iritis, with its troublesome consequences; and hence we must wait for three or four weeks, until all the signs of irritation have subsided, when the lens is again touched with a needle to bring another part of it under the action of the aqueous humour. It may require to be touched three or four times before the lens be got rid of. During the whole course of treatment the pupil must be kept constantly dilated, so that the iris may be prevented from coming into contact with the lenticular *débris*, with which it might form adhesions.

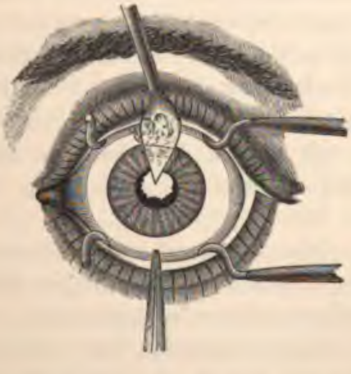
Operation by Linear Incision

I very rarely leave the lens to be got rid of by absorption, considering that many eyes are lost through irritation caused by the lens-substance acting on the iris and other structures. The method which I generally adopt in infantile cataract is as follows:

The patient being under chloroform, and the eyelids held open by a speculum, I seize the conjunctiva and the subconjunctival tisues with a blunt forceps, either in the upper or lower vertical meridian, at a distance of about one sixth of an inch from the corneo-scleral junction. I then introduce the needle and open the capsule. If the lens is found to be fluid it is at once removed by introducing a narrow lance obliquely, into the cornea, and pushing it behind the lens-substance which is floating in the anterior chamber; then, in withdrawing the lance, I depress the scleral margin of the wound, and, by pressing with the fixation forceps, get rid at once of the whole or the greater part of the lens-substance.

When the lens is rather tough only those fragments should be removed which are floating, the rest being left for a future time—say a fortnight or three weeks later—when the needle should be again introduced, and the residuum of the lens

Fig. 60.



broken up and thrown into the anterior chamber, from which it can be removed with a lance. It is hardly ever necessary to use the lance twice for this purpose.

Soft cataract in *adults* I remove in the same manner, using a broad lance for the extraction of the lens. Fig. 60 represents the linear extraction with lance.

The patient being under chloroform, and the eyelids held open by a speculum, I seize the conjunctiva and subconjunctival tissues with the forceps, either in the upper or in the lower vertical meridian, at a distance of about one sixth of an inch from the corneo-scleral junction. I then introduce the lance obliquely through the cornea into the anterior chamber and behind the lens, pushing the iris out of the way. The aqueous humour escapes and the lens advances forwards, and is pumped out, by alternate pressure and relaxation, with the forceps on the one hand, and depression of the lance on the other.

If the incision be found insufficient I enlarge it on each side, and direct the point of the lance toward any *débris* of the lens which may have remained behind. The lens is thus extracted without interfering with the integrity of the pupil. If, however, the state of the parts is such that iridectomy is thought necessary, I introduce the lance, in the first instance, more horizontally, making an opening of about a quarter of an inch, and excise a portion of the iris. I then reintroduce the lance, and enlarge the opening on either side (either by pushing the lance forward, or by pressing it first on the one side and then on the other), until the incision is about three eighths of an inch, pump out the lens, as already indicated.

The reason of limiting the puncture in the first instance is that, after the iris has lost its support from behind, and some of the lens-substance has lubricated its anterior surface, it is apt both to fall back and to become slippery, so that it becomes difficult, if not impossible, to seize it with the forceps.

In cataract in persons after the age of twenty-five, unless its milky appearance indicate a soft condition of the lens, I operate in the same manner as in senile cataract.

I wish you to bear in mind this fact, which I think will be borne out by the experience of most surgeons, that cataract occurring in the two extremes of life is comparatively easily dealt with: in old age the lens is a hard, consistent body, which is easily removed; in infancy it is globular, softish, and not difficult to get rid of; but in the adult, on the other hand, the lens is generally not only tough, but possesses a greater or less degree of vitality, and, if frequently irritated, might take on inflammatory action. I think this worthy of your notice, because we are too apt to regard the lens as insusceptible to inflammation, and any inflammatory mischief which it may set up in the interior of the eye is regarded in the same light as the irritation set up by a foreign body; but this is far from being the case, because the lens itself may take on inflammation, and propagate it to the other structures. I therefore think that the safest procedure with regard to it, is removal, the only difference being that while in senile cataract we may operate without chloroform, in adults the use of anæsthetics is advisable.

Operation by Suction

The method of removing a soft lens by suction was practised by the Persians, and was tried in 1847 by Laugier, of Paris, who employed a pumping needle. Desmarres also tried the procedure, but gave it up. Mr. Teale has of late years revived the idea, and Mr. Bowman, who adopted this operation, has devised for the purpose a very elegant instrument, of which, however, I have never availed myself. In cases of *liquid* cataract the use of this instrument is very enticing, because an immediate result is produced; but such cataracts are comparatively rare, and a *soft* cataract cannot be thus got rid of. We are apt to pump out the vitreous, which is of less density than the lens substance, or drag the other structures, and do damage, while no impression whatever can be made upon the nucleus. A liquid cataract can easily be removed by means of a small corneal puncture, or it disappears in a few days from the anterior chamber, after opening the capsule with a needle, and a *soft* cataract can be removed by a linear incision, after a few days maceration of the lens, with more ease and safety than by the introduction of pumping instruments.

ZONULAR CATARACT

This form of cataract is generally met with among adult persons. There being a transparent zone at the periphery of the lens, rays of light can thus reach the retina; but the imperfection of such sight is evident, as vision can only take place when the pupil is in a state of dilatation.

Operation.—The only operation applicable to it is the formation of a new pupil, which should be made downwards and inwards, and shaped in such a manner—rounded off without cutting the ciliary margin—as not to disturb its contractility.

I operated on a patient some years ago, and restored sight in both eyes to such an extent that he is able to discharge the duties of a mechanical watchmaker.

We have just now (March 1st, 1881) admitted into the Ophthalmic Hospital a boy, aged fourteen, with zonular cataract of both eyes, in whom the opaque portion of the left lens has peculiar greyish points round its margin. We made an artificial pupil in the left eye two months ago, and he has now come to have the other eye operated upon.

DEPRESSING AND COUCHING.

The operations of depressing and couching have played a most important part in ophthalmic surgery. They are performed by introducing a needle through the sclerotic, and by thrusting the lens directly downwards (depression), or by pressing it downwards, backwards, and outwards, so that it should recline with its anterior form directed upwards (called inclination or couching). In either case a bed is made for the lens in the interior of the eye at the expense of the broken up vitreous. When the lens is soft, it cannot be depressed at all, but is merely broken up, and it is partly dissolved, some of it remaining in the aqueous humour, and forming a nucleus for secondary cataract or for something more serious. This operation originated at a period when the doctrine of Celsus prevailed, that the lens was the essential organ of vision, and that cataract was a pellicle formed in front of it, which could easily be depressed and removed from the pupil. Yet even after Köpler (1604) proved that the lens was merely a refracting medium, and Maitre-Jean, Brisseau and others demonstrated that cataract was an opacity of the lens itself, the practice of couching still continued on account of its facility of execution. Nothing can be more easy than to put in a needle and push the lens out of sight, but, alas! for the consequences. Depression, even in such able hands as Dupuytren, has caused some deaths, and in other cases it has been the starting-point of irido-choroiditis, which has rendered the life of the sufferers miserable. The depressed lens may act as a foreign body, detach the retina, or roll forward against the ciliary processes and iris, and thus act as a constant focus of inflammation to harass the patient's life. Depression has well-nigh disappeared from British practice, and will soon have only a historical existence. It has been demonstrated that the couched lens never absorbs, but it remains as a foreign body. Operations of that kind should be left to the Sathiyas of India,[1] and not be revived among us in *any shape whatever*.

Case.—Mrs. K—— consulted me for cataract in the left eye. The right eye had previously been couched, and for upwards of a year had caused her unutterable nocturnal pain and distress. On examining it, I could see that this eye was completely disorganised, and unless it was first enucleated, I refused to operate on the left eye. While she was considering whether she should submit to this, Dr Wallace informed me that she had been seized with herpes frontalis on the side of the couched eye, the herpetic eruptions being situated just on the course of the supra-orbital nerve. I urged the absolute necessity of having the eye enucleated at once, for, whenever herpes shows deep disturbance of the nervous system, sympathetic inflammation may supervene in the other eye at any moment. The eyeball was removed, and the lens was found situated within a bag in the posterior portion of the retina.

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[1] See Mr. Freyers' paper in the 'Lancet,' September, 1879.

The herpetic eruptions disappeared, leaving cutaneous cicatrices. I then operated on the other eye, and vision is now good.

TRAUMATIC CATARACT

Is an opacity produced by an injury inflicted upon the lens or its capsule, either by a foreign body having merely penetrated, or penetrated and lodged within its substance, or by the zonula having been ruptured and the lens dislocated by concussion without an external wound.

A very slight wound to the capsule, as the prick of a pin, is sometimes sufficient to produce opacity of the lens by admission of the aqueous humour into its fibres, and this is traumatism of the lens in its simplest form. When a fragment of metal has penetrated and lodged in the lens, the capsule wound having closed, it sooner or later produces opacity, the time of the completion of the cataract varying according to the size and nature of the foreign body, the violence with which the wound was inflicted, and the nature of the subject. Moreover, as a wound of the lens implies injury to the cornea, and sometimes to the iris and ciliary region, and as, if it be done with violence, the lens may be dislocated, there arise various complications of traumatic cataract, which may be classified as follows:

1. Cataract caused by simple puncture of the lens.
2. Cataract with laceration of the cornea and iris.
3. Cataract complicated with hypopion (coarse injury).
4. Cataract with foreign body impacted in the lens.
5. Cataract with dislocation of the lens :—*a*, into the anterior chamber; *b*, into the vitreous; *c*, partial dislocation; *d*, under the conjunctiva.

1. *Simple puncture* may produce an opacity, which may be confined to the spot of injury, or may gradually extend and involve the whole of the lens. If limited in extent it requires no interference; but when the lens has become entirely opaque it must be dealt with according to the principles which we have now considered, and therefore treated like a cataract caused by malnutrition. A simple puncture, however, when

caused by a coarse instrument, may give rise to purulent infiltration and total destruction of the eyeball. As an instance I may mention cataract induced by a fork. These cases are unfortunately too common in this part of the country among children, who are in the habit of untying their shoe-laces with a fork, which slips and wounds the lens. If it be clean and penetrate about the centre of the cornea, it may produce a simple lenticular opacity; but if it be rusty or penetrate near the ciliary circle, the risk of purulent infiltration is very great. Of the former we have at present two cases in hand.

2. When, in addition to the opaque lens, the cornea and iris have been lacerated, the case requires careful attention; the patient must be kept in bed, both eyes covered; atropine and warm fomentations applied to the injured eye; and only antiphlogistic diet allowed. After the lapse of a few days, when there is no local disturbance and the lens not dislocated, we remove the lacerated portion of the iris, trying to shape the coloboma so as to allow of the free exit of the lens, and leave the extraction for a future occasion, when we remove the lens, according to the requirements of the case; but when we see that the lens-capsule has been very widely opened, and the extraction of the lens cannot be safely postponed, we remove the lens, either with the lance (Fig. 60) or by a curved incision.

3. When there is pus in the anterior chamber, in addition to the cataract, the operation must be strictly limited to the removal of the pus and the performance of iridectomy. Should pus again form it must be removed, so as to prevent injury to the internal structures, and the lens extracted some months later.

I have recorded successful extraction of the lens under such circumstances.[1]

4. The impaction of foreign bodies in the lens is a subject of interest in connection with traumatic cataract, as it enables us to see the pathological changes which take place within the lens fibres, for the lens, having neither blood-vessels nor nerves,

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[1] 'On Improved Method of Extraction, &c.,' p. 9.

cannot be subject to the inflammation which characterises the other tissues. When the change in the lens is associated with inflammation of the iris, the ciliary circle, and the deep structures, the turbidity of the aqueous and its serous opacity render the process complex and obscure; but in cases of traumatism of the lens, the other structures not being involved, we can watch its progress, and see that it is subject to a kind of vegetable inflammation, so well described by Sir James Paget.[1] The tissue change is a slight, slowly-progressing swelling in its elements, due to increased afflux of nutritive matter. In my report on 'Traumatic Cataract'[2] I mentioned a case in which a piece of iron passed through the cornea and iris and lodged in the lens, where it remained for fourteen months without materially affecting vision. I examined the case frequently during that period, until the patient gave up attendance, and with the exception of a circumscribed opacity and thickening in the immediate neighbourhood, there was no tendency to progress.

At present (Jan., 1881) there are two cases in attendance at the Ophthalmic Hospital with pieces of iron in the lens; one is of two years' standing, in which the nucleus is quite opaque, but the anterior layer still transparent; and we have, therefore, postponed extraction of the lens. The other is of eight months' standing, and in it the piece of iron is situated deeply in the lower and inner segment of the lens, and the opacity has travelled very slowly from within outwards until two thirds of the lens are now opaque. Whilst, generally speaking, the progress is very slow—vegetating, as it were—we now and then meet with cases of violent inflammation, set up by a minute foreign body in the lens, when the injury does not involve any other structure.

Case.—John F—, hotel manager, Oban, age 28, met with an accident to his left eye in May, 1880. When driving a nail into a box a piece of iron darted through the centre of the lens. On presenting himself six weeks after the accident I found the pupil contracted, the ciliary circle injected, irides very dark, so that change of colour was not noticeable, the whole lens opaque, and the patient suffering from violent nocturnal pain. I put him under chloroform, made an iridectomy, and extracted the lens by a linear incision. Vision was tolerably good; he could see fingers. Every symptom of inflammation disappeared, and he went home on the tenth day after the operation; but, as the foreign body did not come away along with the lens, I did not consider the case satisfactorily ended, and warned the patient of the possibility of inflammation still being set up, either in the injured or in the uninjured eye, in which case he was to apply at once for relief. In the beginning of August he again presented himself, complaining of dimness of vision in the uninjured eye, which was ushered in by sickness and headache; the sight in the injured eye, though diminished, had not entirely disappeared. On examining the uninjured eye with the ophthalmoscope, and by focal illumination, I found the vitreous cloudy, the uvea of the iris already beginning to form adhesions to the lens-capsule, and, indeed, there were present all the symptoms of acute irido-choroiditis or sympathetic ophthalmia. There being no time to lose I removed the injured eye with deep reluctance and regret.

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[1] Cambridge Meeting of Br. Med. Association, 1880.

[2] Read before the International Ophthalmological Congress in London, 1872.

I found the anterior layer of the vitreous soft, the ciliary circle thickened, and a minute particle of iron (Fig. 61) lodged in the *débris* of thickened lenticular substance at the equator, all the rest of the structures being perfectly healthy. The violent inflammation, however, did not cease after emulation of the injured eye, on the contrary, it took six weeks of a strong mercurial course, combined with large doses of Iod. Potass., to subdue the inflammation completely, and two months more elapsed before the cure could be considered as completed. I have only to add that there was no syphilitic history connected with the case, nor any constitutional taint, but a simple case of sympathetic inflammation setting up through a minute foreign body lodging in the substance of the lens.

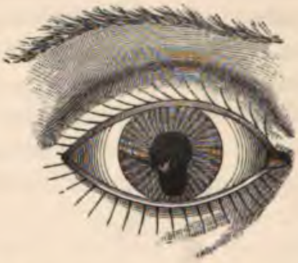
FIG. 61.

An analogous case has been mentioned by Mr. Power.[1]

The contemplation of such cases makes one inclined to think that the lens in adults is itself capable of taking on violent inflammation; hence the great importance in operating upon such cataracts, of securing the evacuation of the entire lens, and the danger of temporising and relying too much on the quiescence of the *dèbris*.

CASE.—*Traumatic cataract, with laceration of cornea and iris, and hypopion—Iron embedded in lens—Evacuation of pus and iridectomy—Extraction—Good sight.*—W. G—, aged 33, boiler-maker, presented himself with an injury of the eye. While he was engaged in cutting a piece of iron a chip from the chisel flew up and struck him. On examining his eye, I found the cornea and iris lacerated and the lens opaque; there was also a little pus in the anterior chamber. I opened the cornea and let out the pus, and also removed a portion of the iris (Fig. 62).

FIG. 62.



Watching the case for several days, I noticed what is unusual in such cases, that the little blood in the anterior chamber did not make any progress towards absorption, and this inactive condition caused me to suspect that there must be a foreign body lodged in the interior of the eye. Now, the test for detecting the presence of a foreign body in the eye is touch. When the eyeball is gently touched in every direction, if the patient start as if pricked, you may assume with certainty that a foreign body is there; if he be passive, then it is possible that a foreign body may be embedded in the lens-substance in such a manner as not to cause pain on pressure. This is likely to be the case when the tear in the cornea is small, but when the tear is large, marking the penetration of a large body, the possibility of such a substance lodging there quiescent must be excluded. Reasoning, therefore, from these premises, I came to the conclusion that a foreign body of sufficient size to inflict such a tear could not lodge in the lens-substance without indicating its existence by causing starting on pressure. Yet, when watching the behaviour of the anterior chamber, the dryness of the iris, and inactivity of the aqueous humour, I became suspicious that a foreign body must be lodged there. Indeed, by-and-bye, when examining the eye by oblique illumination, I noticed a small black speck at the margin of the iris, which was at first taken to be a pigment spot, but I came to the conclusion that this must be the offending body. I opened the cornea at the original wound with a broad needle, touched the piece of iron and drew it forwards, and, in withdrawing the instrument, I enlarged the corneal opening. I then, with the toothed forceps, seized and removed a piece of iron weighing 1½ gr., of the shape and size represented in Fig. 63; I am perfectly at a loss to explain how such an angular body could be lodged in the lens without betraying its existence on pressure. Three weeks later I extracted the lens, and you can satisfy yourselves that the patient enjoys good sight. He reads No. 10 of Jäger. From the form of his pupil you would never suspect that the eye had such a narrow escape.

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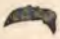
[1] 'Report of International Ophthalmological Congress in London,' p. 84.

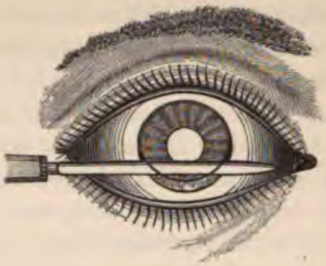
Fig. 63.



In cases like this, the line that divides the region of safety from the necessity of sacrificing the eye is so faint that it requires great watchfulness on your part to lay hold of the phenomena, and judgment to balance the conflicting evidence on each side, in order to arrive at a satisfactory conclusion.

I may mention here also a case of a foreign body in the lens complicated with hypopion,[1] in which I employed the method described by M. Lebrun, of Brussels.

FIG. 64.



This is a sketch of the case of Edward Queen, aged 20, riveter, who was struck with a piece of iron on the right eye. On coming to the institution in July, 1871, four days after the injury, the lens was opaque, with an elevated ridge on its surface, and there was pus in the anterior chamber, and infiltrated into the lower part of the cornea. A curvo-linear section with Graefe's knife was made in the lower healthy portion of the cornea, above the suppurating part, and iridectomy performed, thus giving exit to the pus in the anterior chamber and the lens. On the sixth day the anterior chamber was clear. The patient could count fingers, but the lower part of the cornea still remained opaque, having a yellowish puriform look. At the end of a fortnight this part had cleared, bringing into view a black point, which was at first sight taken for a shred of the iris, but on examination was found to be the point of a piece of iron embedded partly in the cornea at its junction with the sclerotic, and partly in the ciliary processes. This was removed, after which the lower part of the cornea became flattened and the pupil contracted. An artificial pupil was made, which resulted in good sight.

As a rule, however, when the iris and lens have been damaged, the pupil has a tendency to get contracted, and hence the necessity of making the pupil rather larger.

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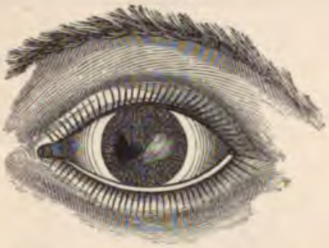
[1] "Traumatic cataract, eighty-two operations" (International Congress, London, 1872).

Case.—B. M—, aged 21, caulker, had his right eye injured by a rivet, a fragment of steel having been driven against the cornea and iris, which it lacerated, and lodged in the lens. The left eye had been destroyed by a similar accident two years before. Linear extraction with iridectomy was performed. The cicatrix of the tear in the cornea remains opaque; the pupil is irregularly contracted, as shown in Fig. 65; but in other respects the sight is good.

Fig. 65.



5. Cataract with dislocation of the lens:

a. When the lens is dislocated into the anterior chamber, it is very easily removed by introducing the lance right under it, giving it a kind of support, and extracting it when broken up (Fig. 60); but when the lens is entire and hard, it must be removed by a curved incision.

b. When the lens is partially dislocated and wedged into the ciliary region, if you were to make a section, the lens being fixed in its position, would not present itself at the opening. The safest way, therefore, is first to put in a needle and push the lens into its proper place, or even a little in the opposite direction, making its margin look towards the portion of the cornea in which you propose to make the incision.

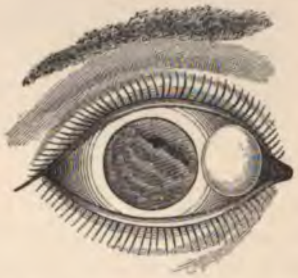
c. When the lens has been dislocated into the vitreous, so long as it is not opaque and is floating, it is generally not safe to interfere, but, should the lens be opaque and the vitreous not disorganised, I operate in the following manner:

The patient being seated before me, with the head reclining slightly forward and supported by an assistant, I introduce a needle through the cornea, depress the handle and keep the lens forward, then entrusting the instrument to an assistant, introduce the lance behind the lens, and thus remove it. In this operation this position is necessary, as otherwise the lens is apt to fall back behind the iris after the corneal section is made.

d. Dislocation of the lens under the conjunctiva.

Fig. 66 represents a case which I admitted some time ago into the Ophthalmic Institution. The patient is a puddler from West Hartlepool, aged 35, whose right eye was injured seven weeks ago by a scrap of iron. At the outer margin of the orbicularis there is a large nodulated cicatrix where the stroke was inflicted. The anterior chamber is shallow, and the iris dragged towards the inner angle, and partly atrophied. He can count fingers at the outer angle. At the inner angle there was a subconjunctival tumour which limited the motion of the eye inwards. I was sure that this could be nothing else than the lens dislocated, and, on opening the conjunctiva I extracted the lens which was softened. The tumour having disappeared and the movements of the eye re-established, I improved vision by the formation of a new pupil.

FIG. 66.



I have operated successfully in a similar accident in the case of an ironmaster.

Mr. Wardsworth recently exhibited a case to the Ophthalmological Society, of dislocation of both lenses under the conjunctiva, in which good sight had been restored.[1]

Brit. Med. Journ.,' Dec. 18, 1880.

LECTURE XII

ON REFRACTION

GENTLEMEN,—In my introductory lecture I have given you a general view of the eye as an object-glass, serving the purpose of projecting images of objects upon the retina. I propose now to enter into a detailed consideration of the subject, and therefore, ask you to glance for a moment at the elementary laws of optics.

Every luminous point sends out light in all directions. Thus, for instance, a burning taper placed in the centre of a spherical surface is visible from all points of that surface, and in like manner the sun sheds its light through space in all directions, its rays reaching the earth and the other planets, whatever their position may be in the boundless expanse of heaven.

As to the nature of light, two theories have been held. The emission theory propounded by Newton was, that light had a material existence, and consists of minute particles of a very subtle nature, which emanate from luminous bodies in straight lines with inconceivable velocity.[1]

The Newtonian theory, however, has now generally been abandoned, and the undulatory theory accepted in its stead. The founder of this great theory was Thomas Young, whom we have already mentioned, and of whom England and the medical profession have reason to be proud. Helmholtz says, "His was one of the most profound minds that the world has ever seen, but he had the misfortune to be too much in advance of his age. He excited the wonder of his contemporaries, who, however, were unable to follow him to the height to which his daring intellect was accustomed to soar. His most important ideas, therefore, lay buried and forgotten in the folios of the Royal Society until a new generation gradually and painfully made the same discoveries, and proved the exactness of his assertions and the truth of his demonstrations." It is interesting for you to know that his fame was obscured for twenty years by the sarcasm heaped upon his writings by Lord Brougham, who had then the command of the 'Edinburgh Review,' the literary and scientific dictator of that period. Thanks, however, to the labours of the celebrated Frenchmen, Fresnel and Arago, and the still more celebrated German Helmholtz, his name has been restored to its commanding position, and his investigations will live in science, whilst his illustrious critic will be remembered only as the defender of Queen Caroline.

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[1] The velocity of light has been variously estimated, as it is calculated from the distance of the sun, which is not easily determined. It may now be accepted as 186,000 miles a second.

According to the undulatory theory, light, instead of being a substance, is a mode of motion, of the nature of a vibration, of the particles of a hypothetical elastic medium (ether), through which it is transmitted from the source of illumination. In this respect light resembles sound, with this difference, that the waves of light are incomparably shorter than those of sound, and the velocity of their propagation incomparably greater.

The theory as to the nature of light, however, does not affect the truth of the assertion that it travels in straight lines—a fact perfectly well known to the ancients. When the source of illumination is at an infinite distance, *e.g.* that of the sun, these straight lines are practically parallel.[1]

Rays of light travelling through the air are broken up into three parts, when they fall upon the surface of a body, such as that of a plate of glass. One portion is thrown back or reflected from the surface; a second travels through the glass, though not in the same straight line as before it entered—in other words, it is refracted, *i. e.* bent out of its former course; while a third, by means of which the surface of the glass becomes visible, is scattered in all directions. Since the first two are the most important theoretically, we therefore have the science of optics divided into *catoptrics*—the laws of reflection, as by mirrors or polished surfaces, and *dioptrics*—the laws of refraction. As the eye is a dioptric apparatus, the laws of refraction alone fall to be considered here.

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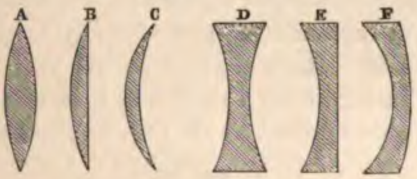
[1] While rays from any luminous body really diverge, yet at a distance of, say twenty feet, they are already practically parallel, and consequently all distances over this are spoken of as infinite, and those under it as finite.

Refraction through Lenses

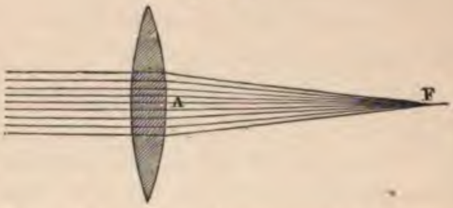
A ray of light may be refracted by its passage through a lens or prism. Lenses are of two principal kinds—convex and concave. These are subdivided into double convex (Fig. 67 A), plano-convex (B), convex meniscus (C), double concave (D), plano-concave (E), and concave meniscus (F). With regard to the meniscus, it may be mentioned that it is called convex or converging when it is thicker in the middle than at the outside, but concave or diverging when the middle is the thinnest part.

Fig. 67.



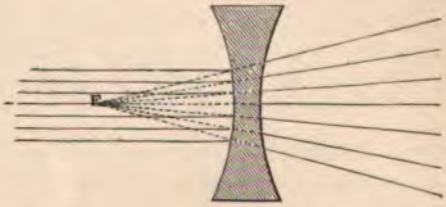
Convex lenses.—If rays of light parallel to the axis fall upon a convex lens, they are by the lens made to converge approximately to one point on the other side of the lens (F, Fig. 68). The point to which such rays converge is called the principal focal point, and this focus is said to be real or positive. The distance of the principal focus from the lens is called the focal distance, and depends, first, on the form of the lens. The focal distance of a lens is inversely proportional to its refracting power; thus, taking a lens of 1 inch focus as a unit, a lens of 2 inches focus would have $\frac{1}{2}$ the refractive power, one of 3 inches $\frac{1}{3}$, of 4 inches $\frac{1}{4}$, of 10 inches $\frac{1}{10}$, &c. But the focal distance also depends on the substance of which the lens is composed. Different materials have different powers of refraction, and the measure of this power is called the index of refraction. The distance of the principal focus is also inversely proportional to the index of refraction, that is to say, if the index of refraction be greater the focal distance will be nearer; if it be smaller the focus will be further removed from the lens. Thus, a lens of dense flint glass, whose index of refraction is approximately $1\frac{3}{4}$, will have its principal focus nearer to the lens than another of the same form, but of crown glass, whose index of refraction is approximately $1\frac{1}{2}$.

FIG. 68.



Concave lenses.—Rays parallel to the axis falling upon a concave lens emerge from it as if they diverged from one point on the same side of the lens (F, Fig. 69), called the principal focal point, and the focus in this case is said to be virtual or negative.[1]

FIG. 69.



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[1] The formula for calculating the focal distance of a lens is—

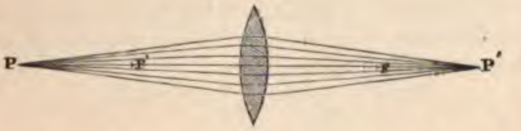
$$\frac{1}{f} = (\mu - 1)\left(\frac{1}{r_1} + \frac{1}{r_2}\right),$$

where f is the focal distance, μ the index of refraction, $r_1\,r_2$ the radii of

We have already seen that rays, falling upon a convex lens parallel to the axis, are by it brought together at the principal focus. If, on the contrary, the rays of light diverge from the principal focus (F, Fig, 68), they will pass through A and emerge from a convex lens parallel to the axis. So also in the case of a concave lens, while parallel incident rays emerge from it as if they had come from the principal focus on the same side as they entered, rays on the other hand entering the lens in lines diverging from a principal focus (F, Fig. 69) will emerge from it parallel to the axis.

Conjugate foci.—Rays falling upon a convex lens from a point (P, Fig. 70) in or near the axis, but further removed from the lens than the principal focus, will converge to a point (P′), a real focus on the other side of the lens. Also rays incident from P′ will, on emerging, converge approximately to P. These points (P and P′), of which each is thus the point of convergence for the other as the source of light, are therefore called conjugate foci.

FIG. 70.



Rays falling upon a convex lens, from a point (P, Fig. 71) in the axis nearer to the lens than the principal focus, will emerge as if they proceeded from a more distant point (P′) on the

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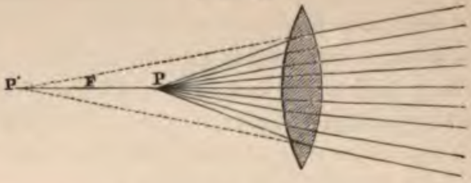
curvature of the two faces of the lens. Remembering that 1 divided by any number gives its reciprocal, the formula may be put in these words: To find the focal distance of a lens, subtract 1 from the index of refraction and multiply the remainder by the sum of the reciprocals of the radii of curvature of the two faces of the lens; the result will be the reciprocal of the focal distance. To make this rule apply to all the six forms of lenses it must be remembered, that f is positive when the principal focus is real, negative when it is virtual; r_1 positive when the first face of the lens is convex, negative when it is concave; r_2 positive when the second face is convex, negative when it is concave; and that μ is the index of refraction from the external medium into the lens.

same side as P. These points are also called conjugate foci, but the focus P′ is now virtual.[1]

FIG. 71.



Rays falling upon a concave lens L L′, from a point (P, Fig. 72) in the axis at any distance whatever, will emerge as a pencil

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[1] In both the cases of conjugate foci given above, the relation between the distances of the conjugate foci and the distance of the principal focus is given in the equation:

$$\frac{1}{p} + \frac{1}{p'} = \frac{1}{f}$$

where p, p' are the distances of the conjugate foci, and f as before the distance of the principal focus. The sum of the reciprocals of the distances of the conjugate foci is here seen to be equal to the reciprocal of the principal focal distance. Thus if the focal length of a lens be 4 inches, while P is at a distance of 6 inches, we have—

$$\frac{1}{4} = \frac{1}{6} + \frac{1}{p'}$$

$$\therefore \ \frac{1}{p'} = \frac{1}{4} - \frac{1}{6} = \frac{1}{12}$$

$$\therefore \ p' = 12 \text{ inches.}$$

In the second case however, the distance of the virtual focus from the lens must be reckoned negative. Thus if $f = 8$ inches, $p = 6$ inches, we have—

$$\frac{1}{6} + \frac{1}{p'} = \frac{1}{8}$$

$$\therefore \frac{1}{p'} = \frac{1}{8} - \frac{1}{6} = -\frac{1}{24}$$

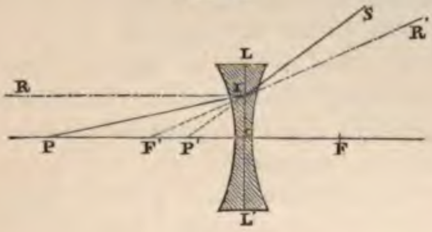
$$\therefore p' = -24.$$

That is, P′ is at a distance of 24 inches, and negative, because the focus is virtual.

of rays diverging from a nearer point P′ on the same side of the lens.

P and P′, as before, are the conjugate foci, F and F′ are the principal foci, and R I a parallel incident ray emerging in the direction of I R′; C is the centre of the lens.

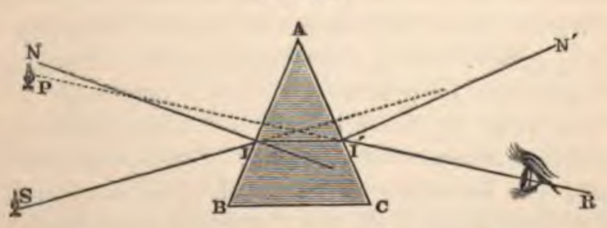
FIG. 72.



REFRACTION THROUGH PRISMS

The second means of refracting rays of light is the prism. A prism is a piece of glass, or other transparent substance, the sides of which are so inclined to each other that its cross section is a triangle, and its action on light passing through it is to change the direction of the course of the beam. From what has been said of lenses, you have already learned that when a beam of light falls obliquely on the surface of a medium, more dense than that through which it has been passing, its direction is changed to a new one, nearer to the line drawn at right angles to that surface, called the normal.

FIG. 73.



In the most common form of prism, the angles of a section made at right angles to its edges are all equal, each being an angle of 60°. Let A B C, Fig. 73, be such a section of a prism. When a ray of light S I passing through air falls upon the surface of the prism at I, it is bent as we have seen nearer to the normal N I, and takes the course I I′ through the glass. When it reaches the other surface at I′ it is again refracted, but now (since it is passing from a more to a less dense medium) in the contrary direction, *i.e.* away from the normal N′ I′, and passes through the air in the direction I′ R. In both cases then the ray of light is deflected towards the thick end of the prism. To an eye placed at R, the ray of light will appear to have come from some point P in the prolongation backward of the line I′ R.

The amount of deviation which a ray of light undergoes in passing through a prism will depend upon the refracting angle B A C of the prism, *i.e.* the angle between the refracting surfaces, and also upon the particular kind of glass of which it is composed. Since the differently coloured rays, of which white light is made up, are not all equally refrangible, it will follow that the light will be broken up, the less refrangible rays at the red end being separated from the more refrangible at the violet end of the spectrum.[1] Consequently the object at which you are looking through the prism will appear with a coloured fringe or border. This is partially got rid of by making the prism as small as possible, or altogether avoided by conjoining a prism of crown glass with one of flint glass, and in this way neutralising the dispersion of the one prism by means of the other. Although we mention here the principle on which achromatic lenses are constructed, such lenses are too heavy to be practically useful, and therefore in ophthalmic practice it is better to use a simple prism, but of a kind of glass (crown glass) whose power of dispersion is weak relatively to its refracting power. Also, while prisms with a refracting angle of 60° are in use for general purposes in optics, for prismatic spectacles a feebler power is sufficient, and prisms are made with angles varying from 2° to 20°. Such prismatic glasses are numbered according to their refracting angle, *e.g.* No. 2 is one with an angle of 2°, No. 6 one with an angle of 6°.

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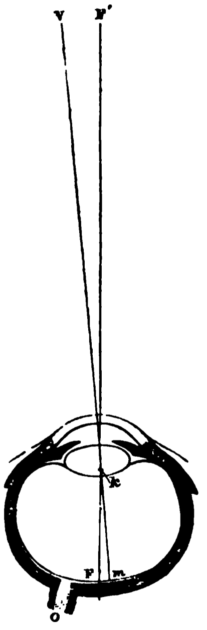
[1] See Perception of colour.

Refraction in the Eye

These elementary principles of optics will enable you to understand how refraction takes place in the eye, which is in reality a compound convex lens. The cornea is a simple surface, covering the aqueous humour, and, therefore, as it does

Fig. 74.



not contribute to the refractive power of the eye, may be here disregarded. The aqueous humour, on the other hand, is one of the refractive media, its index of refraction being $\frac{103}{77}$. Since the vitreous humour has the same index of refraction, it may be regarded as, in this respect, one with the aqueous humour. Embedded within these is the crystalline lens, whose index of refraction is $\frac{16}{11}$, and the refractive power of the eye is the result of the combined action of these two refractive media.

Angle a.—What is known as the optic axis is an imaginary straight line (F F′, Fig. 74), drawn through the centre of the cornea to a point situated on the retina between the macula lutea and the entrance of the optic nerve (o). Round this line the whole optic apparatus is symmetrically disposed, so that it exactly corresponds to the axis of an optical instrument. In such an instrument it coincides, or is identical with the visual line, and so also was it formerly considered to be in the eye, but Helmholtz has shown that the visual line is another straight line (v *m*), which joins the point of fixation with the macula lutea. In front of the eye, the visual line is situated generally to the inside of and more frequently a little above the optic axis, the fovea being to the outside and a little under the axis. These two lines intersect at a point called the nodal point (*k*), which is near the posterior surface of the lens. There is thus formed at the nodal point an angle, which is generally referred to as the angle *a*. In the emmetropic eye this angle is about 5°; in the hypermetropic it is 7°, or even more; and in the myopic it is less than 5°, diminishing until sometimes the visual line coincides with the optic axis, while in extreme cases it crosses to between the axis and the entrance of the optic nerve, and the angle is then reckoned negative.

ACUTENESS OF VISION.

Visual acuity depends on the sensibility of the retina, just as the sense of touch does on the skin. In the latter case, we measure the sensibility by the smallest distance at which the mechanical pressure of each point of a pair of compasses is separately felt, and in the former by the least distance between the images of two luminous points, which can be clearly distinguished. This distance corresponds to an angle, which is called the smallest visual angle, and in eyes of average acuity is an angle of one minute. On this principle Snellen has constructed his "test-types," each of which at its proper distance should be seen at an angle of five minutes, while the separate parts of each letter should be seen at an angle of one minute. In order, therefore, to distinguish one letter from another, an eye must be able to see distinctly objects at an angle of one minute, *i.e.* the sixteenth part of a degree.

The size of the image formed on the retina depends on this smallest angle, and the distinguishing power of the eye increases, though not in direct proportion, with the growth of this image. The degree of acuteness of vision is therefore measured by the smallest angle at which objects of known size and form can be distinguished, which angle, again, is determined by the utmost distance at which objects of definite size can be recognized. This angle of one minute with the corresponding distance at which each letter should be recognized being assumed as a standard, the acuteness of vision is expressed by the distance at which the object is actually seen, divided by the unit distance.

This is expressed by the formula, $V = \frac{d}{D}$ where V is the measure of acuteness of vision, d the distance at which the object is actually seen, and D that at which it ought to be visible. If $d = D$, then vision is normal, being $= 1$; but if d be less than D, then the eye is deficient in acuteness. Snellen has so arranged his test-types, that I ought to be visible at a distance of 1 ft., II at a distance of 2 ft., XX at a distance of 20 ft., and so on up to CC at a distance of 200 ft. Thus, if at a distance of 20 ft. XX is visible, acuteness of vision is expressed by $\frac{20}{20}$ or 1, that is to say, it is normal; but if XXX be the smallest visible, acuteness of vision is $\frac{20}{30}$, *i.e.* $\frac{2}{3}$; or if XL be the smallest visible, it is $\frac{20}{40}$ or $\frac{1}{2}$, &c.

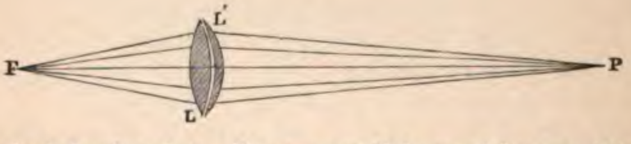
RANGE OF ACCOMMODATION.

We have already seen (page 17) that in the human eye accommodation is effected by the ciliary muscle, which presses on the rim of the lens, rendering its anterior surface more convex, and thereby lengthening its axis. The eye is thus accommodated for near vision. The anterior surface, while increasing considerably in convexity, at the same time advances forward; the posterior surface, on the other hand, becomes a little more convex without altering its position. By these complicated modifications the positions of the cardinal points of the lens, and also of the whole eye, are altered. The focal distance of the lens becomes shorter, just as if the lens had received the addition of a positive meniscus. Therefore the range of accommodation is to be determined from the focal distance of such an auxiliary lens.

The furthest distance to which an eye can see we call the *punctum remotum* (r), and the shortest distance to which it can be accommodated the *punctum proximum* (p). It thus follows that 1 divided by the focal distance of the meniscus, which the eye adds to itself in adjustment for the nearest point, gives the numerical expression for the range of accommodation, the power of a lens being, as we have seen, inversely proportional to its focal distance.[1]

In Fig. 75 let L be a double convex lens, and F its principal focal point. If now parallel rays fall upon this lens they converge to F, where a distinct image will be formed upon an interposed screen; but if diverging rays from a point (P) fall upon it, they will converge to a more distant point on the same side as F, and consequently no distinct image will be formed on the screen at F. To get a distinct image the screen

FIG. 75.



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[1] This can be determined from the positions of the far and near points, by means of the formula— $\frac{1}{A} = \frac{1}{P} - \frac{1}{R}$, where $\frac{1}{A}$ is the range of accommodation, P the distance of the near point (p) and R the distance of the far point (r). The formula may also be put $\frac{1}{A} + \frac{1}{R} = \frac{1}{P}$, *i.e.* the refraction of the eye in a state of relaxation added to the accommodation, gives the near point. Thus, if $P = 4$ inches, and $R = 12$ inches, then $\frac{1}{A} = \frac{1}{4} - \frac{1}{12} = \frac{1}{6}$, *i.e.* the accommodation is equivalent to the addition of a meniscus of 6 inches focal length.

must be removed backwards. But if this cannot conveniently be done the rays may still be made to converge at F by placing in front of the lens—*i. e.* between it and P—a convex meniscus (L′) of suitable focal length. In order to do this the focal length of the meniscus must be such that rays falling on it from P emerge from it, and, therefore, fall upon L parallel to the axis. Now, in the human eye the increase of convexity of the anterior surface of the lens is, as we have said, precisely analogous to the addition of the convex meniscus to the lens L.

LECTURE XIII

ANOMALIES OF REFRACTION

Gentlemen,—An emmetropic eye is one which, during relaxation, is so adjusted that parallel incident rays converge to a point on the retina, which is thus situated at the principal focus of the dioptric system. Its punctum remotum is situated at an infinite distance.

All eyes which are not emmetropic are ametropic, *i. e.* parallel incident rays are united, not on the retina, but either in front of or behind it. Ametropia is subdivided into *hypermetropia* and *myopia*.

Hypermetropia

An eye is called hypermetropic when the retina is in front of the focus of the dioptric system or the focus behind the retina, and, therefore, there is a circle of diffusion on the retina. The punctum remotum of such an eye is nowhere. A hypermetropic person has no distinct vision, and any distinct images he has must be formed by the power of accommodation. It is by this means that hypermetropes see objects at a distance, or even comparatively near at hand. Such a person usually complains that he cannot read or do near work for any length of time. After looking for a short period the lines and letters run together, and then disappear; but if he shut his eyes for a minute he can continue to work or read for a short time longer, after which the letters, &c., become indistinct as before. When a person complains that he cannot continue work for any length of time without the letters running together we test him with the convex glasses. Commencing with the feeble, say those of 36 inches focus, we go upwards and arrive at the strongest with which he can distinguish XX letters at 20 feet distance. The focal distance of this lens indicates the degree of his hypermetropia, because if his eye requires such a convex lens in front of it, in order to bring the rays to a focus on the retina, that is a proof that the eye is so far deficient in refractive power. Hypermetropia is expressed by a fraction, whose numerator is 1, and denominator the focal length of the strongest convex lens he requires, *e. g.* if he requires a convex lens of 24-inches focal distance, $H = \frac{1}{24}$, or if one of 12 inches $H = \frac{1}{12}$.

The hypermetropic eyeball is one imperfectly developed or naturally feeble. It is generally an inheritance, and usually connected with a peculiar appearance of the face. So long as his ciliary muscle is in full power, or the degree of hypermetropia is not very great, the individual can work it well without inconvenience; but as age advances, and accommodation is more and more called into play, for the purpose of reading or other employment, he begins to feel the inconvenience.

Hypermetropia may be caused, first, by the axis of the eyeball being abnormally short, so that parallel rays unite, not on the retina, but behind it. This is known as axial hypermetropia, H^a.

Or, second, it may be caused by the refractive power of the eyeball being feeble relative to its length, through diminished convexity of the cornea or lens, H^c, hypermetropia of curvature. Or, again, the index of refraction of the aqueous humour or of the lens may be diminished, H^i. Hypermetropia may also be caused by the want of, or dislocation of the lens, as after operations for cataract.

In the first, then, there is arrested development of the eye in its totality in its antero-posterior diameter. The eyeball is small and mobile. When it is turned towards the nose and the lids raised we see that the equatorial portions are strongly curved, and that the back part slopes suddenly towards the posterior pole. In the second the cornea may be depressed by ulcers or by inflammation.

In the treatment of hypermetropia we refract the rays, and make them converge before they reach the cornea, so that they may be focussed on the retina without calling in the aid of accommodation. Hence it is cured by interposing lenses to do this. But sometimes, although you supply the patient with the strongest glasses, he comes back, after a little time, complaining that still he is not able to see distinctly. The reason generally is that a person who has been in the habit of using his power of accommodation can with difficulty relax it in trying the glasses, so that after you have neutralised his hypermetropia there is still some part of it left latent. This is called latent hypermetropia, H^l.

In such a case it is best to paralyze his accommodation by a solution of atropine, and then give him the strongest glasses, with which he can see distinctly. In fact, spectacles must be ordered which will neutralize both his manifest and latent hypermetropia.

ASTHENOPIA—HABITUDO VISUS—AMELYOPIA PRESBYOPIQUE —FATIGUE DE L'ACCOMMODATION

There is a morbid condition of the eye called asthenopia—a term which you will see frequently mentioned in medical works. It is also characterised by inability to continue work for any length of time. The power of vision is usually acute, but the eyes very soon get fatigued, especially when exposed to artificial light or in a gloomy place. Objects become indistinct and confused, and a feeling of fatigue and tension comes on, so that the person must close his eyes and give them a rest. After Sunday's rest such a person can resume his work with renewed energy, only, however, to relapse into his former condition. This tension when long continued soon produces pain and redness, hyperæmia of the conjunctiva, cyclitis, and even retinal congestion. At first this condition was considered to be a kind of amblyopia, then the cause of it was sought for in the action of the muscles of accommodation, and the fact that thousands work without being thus fatigued, whilst children are sometimes affected who have not strained their accommodation at all, was explained by the assumption of a peculiar predisposition to asthenopia. You will, therefore, understand why, having got such a convenient term, we should have continued to conjure with it, and should have extended its application. The study of medical nomenclature is highly instructive, words being still employed traditionally which represent exploded doctrines. The fact is, as Donders has demonstrated, that asthenopia is always the result of latent hypermetropia. Fatigue de l'accommodation is, therefore, a better term, because tension of accommodation is required, even for employment in which the emmetropic eye has its accommodation relaxed. From youth upwards the eye adapts itself to these requirements as far as it is able, yea, it even hides a moderate degree of hypermetropia (rendering it latent); but as the eye gradually, from age, parts with its amplitude of accommodation, in the same degree does asthenopia set in. At first this is only under less favourable conditions of illumination and extraordinary exertion, but subsequently on all occasions without exception, when close work is performed, even for a comparatively short time. In general the symptoms of asthenopia show themselves earlier, the higher the degree of hypermetropia on which it depends, so that the year of life when asthenopia becomes obtrusive may be put as the denominator of the fraction by which hypermetropia is expressed. Thus, when a person aged 35 complains of asthenopia you will find that hypermetropia is $\frac{1}{35}$; when it shows itself at the age of 20, $H=\frac{1}{20}$; at the age of 10, $H=\frac{1}{10}$; when above 40 years of age it begins to coalesce with presbyopia. To understand this you must bear in mind the work which the ciliary muscle is called upon to perform in such cases. It must first supply the deficiency of refraction, even in looking at distant objects, and then in looking at near objects it must do the work of accommodation. Hence, like every other muscle, it gets fatigued by over-exertion, and gradually becomes exhausted. When exhaustion is pushed far, rigidity ensues.

Asthenopia, then, being the result of latent hypermetropia, it follows that it also is an inheritance. The nature of the inheritance may, according to Dr. Hughlings Jackson,[1] be compared to that of insanity or phthisis. In cases of a tendency to insanity, what is transmitted is not a diseased brain but only an imperfectly developed, though a healthy one, the highest cerebral centres are ill-developed, and the lower ones in comparison are over-developed. A person with such a brain easily becomes excited with alcohol, easily delirious during an acute illness, and is more liable than other persons to have insanity after an acute illness. He begins his mental life with a deficit. So also the inheritance of phthisis is an inheritance of small lungs—of lungs easily overworked.

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[1] 'British Medical Journal,' May 12th, 1877.

In the same way, as Donders says, "The hypermetropic individual begins his accommodation with a deficit." In other words, in those who inherit a tendency to asthenopia, there has been transmitted a healthy but a small and imperfectly-developed eye.

MYOPIA

Myopia is that condition of the eye in which the retina is situated behind the focus of the dioptric system, in other words, the refractive power of such an eye is too strong relatively to its length. In relaxed accommodation its punctum remotum is situated at a finite distance in front of the eye. Its punctum proximum is perfect, *i. e.* it sees the near point without straining its accommodation. It is therefore an optical instrument adapted for finite distances.

The forms of myopia are :—1. The eye is too long in its antero-posterior diameter, and the eyeball assumes the form of an ellipsoid. The distension takes place mostly at the posterior pole, and near to the optic nerve. This is known as axial myopia, M^a. It is the most frequent form of myopia. The eye is of such a length that its mobility is impeded. It is generally connected with distension (ectasia) of the sclerotic near the entrance of the optic nerve (staphyloma posticum).

2. The refractive power of the eye is too strong from excessive curvature. The conical cornea may be given as an example of this form of myopia, M^c.

3. The index of refraction may be increased, M^i. This is sometimes developed in cataract from the increase of the index of refraction of the lens.

When a myopic person tries to look at objects at a distance, he screws up his eyelids so as to narrow the palpebral aperture (hence the term myopia from μύω I close, ὤψ eye), and is only able to make out the objects indistinctly, or perhaps in some cases not at all. You measure the degree of his myopia with concave lenses. First place the patient at a distance of twenty feet and ask him to read without lenses, and with each eye separately the letters X X up to C C. If the degree of myopia is strong he will not be able to read any of the letters, but if he can read some of them we try the concave glasses. To corroborate the measurement by the lenses, put the small types into his hand and measure with a tape the distance from the cornea to the letters, at which he reads the types. That distance corresponds to the focal distance of the concave lens required to neutralize his myopia. For example, if in reading the patient holds the type ($1\frac{1}{2}$ or 2 of the test types) at a distance of five inches, then a 5-inch concave lens (*i. e.* one of five inches negative focus) will be the one which will improve distant vision most. Giving him the concave lenses, we try him successively with a weaker and weaker lens, until we ascertain the weakest with which he can read X X at twenty feet. The limit is passed when we reach a lens which diminishes the distinctness of vision. In so testing him we must not trust to the simple statement of the patient that he sees better, but try by the types whether vision is really more distinct. The degree of myopia may then be expressed by placing the negative focal length of this lens for the denominator of the fraction, and one for the numerator. Thus, if a concave lens of 20-inches' focus is the weakest with which X X can be read at a distance of twenty feet $M = \frac{1}{20}$, if with 10-inches' focus $M = \frac{1}{10}$, &c.

We have said that in hypermetropia we supply the strongest lens, whilst in myopia we give the weakest. The reason is, in hypermetropia we have to give the strongest in order to neutralize perfectly his accommodation. There is no fear that a stronger lens will be used than is absolutely necessary, for then the eye would be converted into a myopic. But, on the other hand, in myopia our object is to correct the strong refractive power of the eye in order to enable the patient to look at a distance. If now we give him too strong a concave lens, we shall call his accommodation into play in order to neutralize this concave lens. This we seek to avoid by giving him rather a weaker lens. He will not be able by it to see very far, but we thus run no risk of straining his accommodation. Glasses are accordingly given him one or two inches weaker than he absolutely requires, especially in myopia above $\frac{1}{6}$.

There is a very simple method of determining if a lens is too strong. If vision is most distinct when the lens is close to the eye we have got a lens of proper focal length, but if on withdrawing it from the eye and thus removing the negative focal point beyond the far point, vision is as distinct, or even more so, then the lens is too strong.

I recommend myopics to use concave glasses only for distant vision and such employment as piano playing, and in no case to use them for near work, such as reading or writing. Further, in high degrees of myopia, when it is complicated with opaque vitreous or disease of the choroid, we interdict the use of glasses altogether, so that vision may be entirely spared, for an inconsiderate use of concave glasses may become highly injurious.

Ophthalmoscopic Appearance of the Myopic Eye

Changes are almost always observable about the optic disc. There is, as a rule, a sharply defined sickle-shaped or crescentic spot on the temporal side close of the disc (figs. 1 and 2, Plate IV). There is more or less atrophy of the choroid, and in most cases there is unmistakable atrophy of the stroma. Ectasia of the sclerotic may go on to such an extent and the staphyloma be so largely developed as in certain circumstances to give rise to softening of the vitreous humour. This is more to be apprehended in the higher degrees of myopia, $M = \frac{1}{6}$ and upwards. The distension sometimes causes a separation between the outer and inner nerve-sheaths. The inner is adherent to the nerve itself, while the outer is continuous with the sclera; therefore, any distension of the sclera will withdraw the outer sheath from the inner, and thus increase the space between the two.[1] The place of entrance of the optic nerve on the outer surface of the sclera may thus attain a diameter of 8 mm. or more, so as to present the appearance of the optic nerve set upon a second terrace of the staphyloma.

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[1] See 'Anatomy of Optic Nerve Entrance.'

The choroid remains normal in its anterior part, and the changes are greater close to the optic disc where nothing remains of the choroid but a thin, structureless, transparent membrane, containing no trace of blood-vessels or even capillaries. A further consequence of this distension of the choroid is that the anterior portion of the ciliary body, the iris and lens, move backward. Hence, the anterior chamber is generally deepened, and the ciliary muscle on the edge of the cornea may, by this process of traction, be atrophied.

In high degrees of myopia the choroidal atrophy extends around the whole optic disc. The disc then appears surrounded by a white ring, whose breadth is greater on the temporal than on the median side. Choroidal atrophy is almost always present in myopia, and, according to Donders, there is quite a uniform average relation between the extent of the atrophy on the one hand and the degree of myopia and the time of life on the other. At all events, the connection between them is undoubted.

On this point there only remains to be explained the reason of the choroidal atrophy being on the temporal border of the optic nerve, namely, because around the optic nerve the choroid is closely attached to the sclera, and often sends fibrous processes into the nerve itself. At this place, therefore, the choroid cannot so easily escape the strain as it can in other localities where it is more loosely connected with the sclera. Now, because the eye is most distended in its antero-posterior diameter, hence the choroidal atrophy begins just on the temporal side of the optic nerve.

In most cases myopia is congenital, but may also be acquired. Cohn, who has examined many thousands of children, holds that it is developed by insufficient illumination, by the habit of stooping at school and by straining the accommodation. It may be induced by intraocular pressure and strong convergence of the visual axes, while a bowed condition of the head favours the distension of the sclera and passive hyperæmia, and elongates the axis. Hence it is of importance that children should be taught to read with head erect, and not in twilight or insufficient illumination. In the designing of schools careful attention should be given to th lighting, and the desks should be made of such a height slope as to prevent stooping as much as possible. T therefore, in most cases the cause of myopia is cong weakness of the posterior part of the sclera, it may at the same time be induced by the above causes. This is proved by myopia being often developed in children shortly after measles and scarlet fever. It may also be induced by cloudiness of the cornea. Owing to indistinctness of the retinal images, the patient seeks to compensate by increase of size for indistinctness, therefore he takes the object near to his eye and there results strong convergence.

Irritation frequently sets in at the period of puberty, and is characterized by hyperæmia of the optic nerve, fatigue and pain in the eyes, especially when working by artificial light. This condition requires strict attention. Every tendency to congestion of the head must be avoided, the bowels kept open, and work by artificial light given up.

If there is spasm of the muscle of accommodation, the muscle must be completely paralyzed by the use of atropine and coloured glasses worn. The use of atropine is continued for a considerable time, and the degree of myopia then determined.

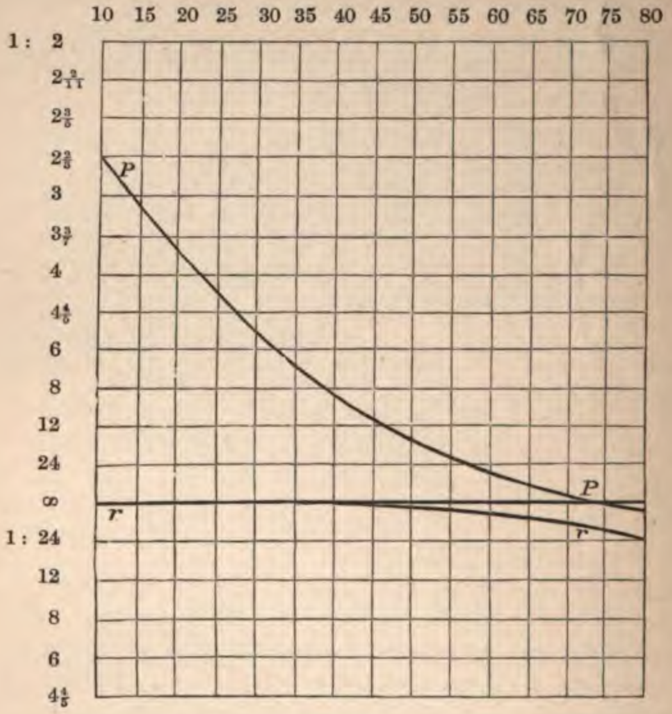
Myopia generally remains stationary through life, or in old age may even show a decrease, very probably due to the contraction of the pupil, by which the circle of diffusion is made smaller, or by changes in the lens itself, such as flattening of the lens. Thus in old age weaker concave glasses may be required than in earlier years. In other cases, myopia is rapidly progressive, especially up to twenty-five years of age, and then remains stationary.

Myopia of moderate degree, say $= \frac{1}{10}$ or $\frac{1}{14}$, which remains stationary, is a condition rather to be envied by hypermetropes and even by emmetropes; for at an advanced age such a person can see minute objects without the use of convex glasses, and simply by the refractive power of his eye. It is only when myopia reaches a high degree, *e.g.* = $\frac{1}{6}$, that it is apt to be complicated with amblyopia, and thus brought within the region of pathology.

Presbyopia—Range of Accommodation Modified by Age—Hypermetropia Acquisita

Presbyopia (πρέσβυς, old; ὤψ, the eye) is that condition in which, as the result of increase of years, the range of accommodation is diminished, and the vision of near objects interfered with. The refraction of the eye, and still more the range of accommodation become modified as age advances. The diminution of the range of accommodation takes place before any change in the refractive power, commencing as it does in youth, even before the period of puberty. We know that in advanced age the lens is firmer than in youth. This increase of firmness commences at an early period, and it is in consequence of this greater firmness that the same muscular action can no longer produce the same change in the form of the lens. It is therefore very probable that the early diminution of accommodation $\left(\frac{1}{A}\right)$ depends on the condition of the lens. But in addition to this, as age advances, the lens becomes flatter, on which account the radii of curvature of its surfaces and its focal distance are increased. Donders, who established the law of diminution of accommodation, has given a diagram to represent the amplitude of accommodation at different periods of life. In this diagram, the numbers in the horizontal line at the top give the different periods of life at intervals of five years; while the numbers to the left in the vertical line give the distances in Parisian inches, for which accommodation can take place. Those below ∝ have a negative signification, and represent the distances at which the converging rays, for which the eye is accommodated, come to a focus behind the nodal point. On the lines *p p* and *r r* we can therefore, for each year of life, read off the nearest and furthest points of distinct vision, and the distance between the two lines gives the range of accommodation, the distance between any two consecutive transverse lines being = $\frac{1}{24}$ accommodation. From the diagram it will appear, that even

Fig. 76.



from the tenth year the near point recedes from the eye, or, in other words, *p*, the punctum proximum, approaches *r*, the punctum remotum. At the age of 30 the range of accommodation $\left(\frac{1}{A}\right)$ has fallen to about one-half of what it was at the tenth year. From this time the change takes place much more gradually. The furthest point on the other hand remains at the same height up to the fortieth year, and then begins an extremely slow descent. At the age of 50, an emmetropic eye becomes somewhat hypermetropic, and at the age of 80 this hypermetropia reaches from $\frac{1}{24}$ to $\frac{1}{10}$.

Presbyopia, therefore, is not so much an anomaly of refraction as a normal condition resulting from the advance of years, just as grey hairs and wrinkling of the skin do. It generally begins at the age of forty-five, when small type has to be put aside and minute objects are seen with greater difficulty, though ordinary occupations are still carried on even in the evening. The age of forty-five being accepted as the time when it commences, we may hence derive a standard by which to measure the degree of presbyopia. At this age the binocular nearest point, p_2, often lies at a distance of eight Parisian inches from the eye. If, then, at any age p lies at a distance of n Parisian inches from the eye, the degree of presbyopia, $\mathrm{Pr} = \frac{1}{8} - \frac{1}{n}$. For example, if $n = 16$ inches, then $\mathrm{Pr} = \frac{1}{8} - \frac{1}{16} = \frac{1}{16}$, or if $n = 24$ then $\mathrm{Pr} = \frac{1}{8} - \frac{1}{24} = \frac{1}{12}$.

So far we have spoken of presbyopia only in the emmetropic eye, but myopes and hypermetropes are subject to the same change of conditions. In the myopic eye, however, presbyopia takes place later in life. The established law being that it begins at forty-five years of age in a normal eye, if glasses are not required by any person till fifty years or over, we shall find, on testing him, a slight degree of myopia, which compensates for the diminution of his range of accommodation. Hypermetropia, on the other hand, at this time of life coalesces with presbyopia, so that then the correcting glasses, which such cases require, must be relatively stronger to compensate both for the deficiency of refraction and for the diminished power of accommodation.

Presbyopia can be corrected by means of convex glasses. The need for them arises so soon as, by diminution of accommodation, the required accuracy of vision begins to fail, and the use of them is not to be postponed any longer. The following table gives approximately the proper glasses to be supplied to an emmetropic eye at the different ages for the purposes of writing or reading ordinary type; the third column indicates the distance which is preferred for vision with these glasses.

Age.	Glasses required.	Distance of Distinct Vision.
48	$\frac{1}{60}$	14″
50	$\frac{1}{40}$	14″
55	$\frac{1}{30}$	14″
58	$\frac{1}{22}$	13″
60	$\frac{1}{18}$	13″
62	$\frac{1}{14}$	13″
65	$\frac{1}{13}$	12″
70	$\frac{1}{10}$	10″
75	$\frac{1}{9}$	9″
78	$\frac{1}{8}$	8″
80	$\frac{1}{7}$	7″

There are certain conditions under which the range of accommodation does not correspond to the time of life, *e. g.* in general debility the result of exhausting disease, premature old age, in cases of glaucoma simplex, or at the commencement of cataract, which hastens on presbyopia through rapid hardening of the lens. We need hardly mention cases of paralysis of the ciliary muscle, as the result of diphtheria; this will come up again for consideration under paralysis of the ciliary muscle.

We must remember that glasses can be of use only to compensate for refraction and tension of accommodation, when the acuteness of vision is normal. But in cases of diminished acuteness of vision, glasses can only do harm, and we must rather recommend the use of larger type and coarser work to avoid fatiguing the eye. With regard to the use of coloured glasses, I may say that I always discourage their use, because they deprive the eyes of their natural stimulus of white light, and induce a predisposition to retinal congestion.

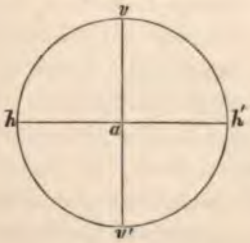
LECTURE XIV

ASTIGMATISM

GENTLEMEN,—Astigmatism (ἀ, priv.; στιγμα, a point) consists of an irregularity of curvature of the dioptric surfaces, which deviate in various degrees from the normal spherical form. For the proper understanding of this subject, we must first explain what is meant by the meridians of the eye, and especially the vertical and horizontal meridians. Meridians are imaginary lines on a spherical surface passing through both poles of the sphere. In the case of the eye they pass through the anterior and posterior poles; that which does so in a vertical direction, and the plane of which divides the eye into temporal and nasal hemispheres, being called the vertical meridian; that, on the other hand, which lies in a horizontal direction, and the plane of which divides the eye into upper and lower hemispheres, being known as the horizontal meridian.

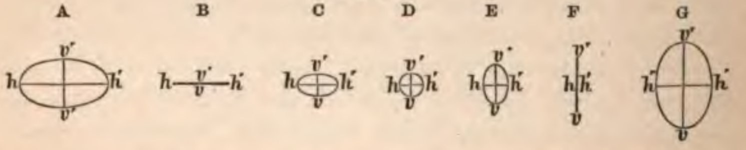
Now, it is found, even in normal eyes, that the curvature is not the same for all meridians. The refraction, therefore, is not the same in all meridians, but strongest where there is greatest curvature, and feeblest in the line of least curvature.

FIG. 77.



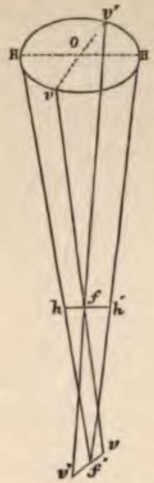
These lines we speak of as the principal meridians. The vertical meridian is, in most cases, that of the shortest radius of curvature, and the horizontal that of the longest. If, then, rays of light, coming through a circular opening, fall upon an eye (Fig. 77) whose maximum curvature is in the vertical meridian and minimum in the horizontal, those in the line *v v′* will, therefore, be most strongly refracted, and brought to a focus sooner than those in the line *h h′*. If now we make a cross-section of this cone of rays, before any of them have come to a focus, we shall find it of the form of an oblate ellipse (Fig. 78, A), whose major axis is *h h′*, and minor axis *v v′*. As we make this section nearer and nearer to the focus of rays in the plane *v v′* the axis *v v′* will be found to diminish until, at the focus itself, the points *v v′* coalesce and the ellipse becomes a horizontal line (B). Further back than this the section is again an oblate ellipse (C), with increasing vertical and diminishing horizontal axis. This change goes on until by the axes becoming equal in length, the section takes a circular form (D), then that of a prolate ellipse (E), while at the focus of the rays *h h′* it becomes a vertical line (F), beyond which it again assumes the elliptical form (G). Such a cone of rays forms thus either a line or an image of diffusion, either circular or elliptical in form, but can never unite in a single point, and consequently the eye we have been considering is called astigmatic. Fig. 79 will also illustrate this. Let o be the circular section of monocentric rays before falling upon such a dioptric system. After refraction the rays in the plane *v v′* will converge at *f*, and those in the plane *h h′* at *f′*. The distance between the lines *h h′* and *v v′*, of which, if one be in the plane of the figure the other is at right angles to it, is called the focal interval of Sturm. It is to Sturm that we owe the theory of refraction by such asymmetrical surfaces. It will be evident that the greater the asymmetry the longer will be the focal interval

Fig. 78.



($f\ f'$), and the longer the focal lines ($h\ h'$, $v\ v'$) which bound it.

FIG. 79.



Focal interval of Sturm.

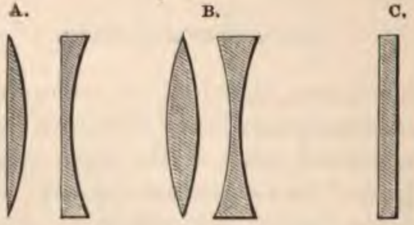
From such a system, therefore, we can never get a distinct image of a luminous point; for at whichever focus we place the screen the rays which unite at the other focus will form an image of diffusion. In the one case we have a simple vertical and in the other a simple horizontal line. Accordingly, if an eye has its vertical corneal meridian of greater curvature than its horizontal it will, when looking at a point, always see a vertical or horizontal line, or an elliptical luminous spot.

Astigmatism is of two kinds—*regular* and *irregular*. It is called regular astigmatism or meridional asymmetry when the curvature is the same along the whole length of the same meridian, though different for different meridians, and irregular when there are different curvatures at different parts of the same meridian. Regular astigmatism depends generally on the cornea. The maximum of curvature generally lies nearer to the vertical, and the minimum nearer to the horizontal meridian, just as if the eyeball had received its irregularity of form by pressure at the two ends of the vertical axis. This kind of astigmatism is found more or less in all eyes. Two threads, at the same distance and at right angles to each other, are not seen by any eye with equal distinctness.

Although regular astigmatism usually depends on the cornea, yet it may be modified by the lens, either by the form of its surface or by its oblique position, and therefore it does not exactly correspond, either in degree or in direction, to the form of the cornea. Since every eye is to a certain extent astigmatic, so long as it does not sensibly diminish acuteness of vision it is normal, and only becomes abnormal when it is present in such a degree that vision is perceptibly indistinct. If astigmatism is $\frac{1}{40}$ or more it must be considered abnormal, and its correction is then desirable.

The peculiarities of refraction in an astigmatic eye can be imitated by casting images upon a screen through a cylindrical lens. Such lenses are formed by sections of a glass cylinder parallel to its axis, or two such sections symmetrically associated. Fig. 80 shows sections of cylindrical convex and concave lenses, A and B perpendicular to the axis, and C parallel to the axis. A convex cylindrical lens, like all convex lenses, refracts rays of light falling upon it at right angles to its axis, but has no effect on rays parallel to the axis. Similarly a concave cylindrical lens only disperses those rays which are at right angles to its axis. If we now unite a convex cylindrical lens with a convex spherical lens, rays parallel to the axis will be affected only by the spherical lens, while those perpendicular to the axis will be refracted by both, and will be brought to a point at some distance from the focus of the other rays. At either focus, therefore, there will be formed an image of diffusion. This, however, may be removed by the

FIG. 80.



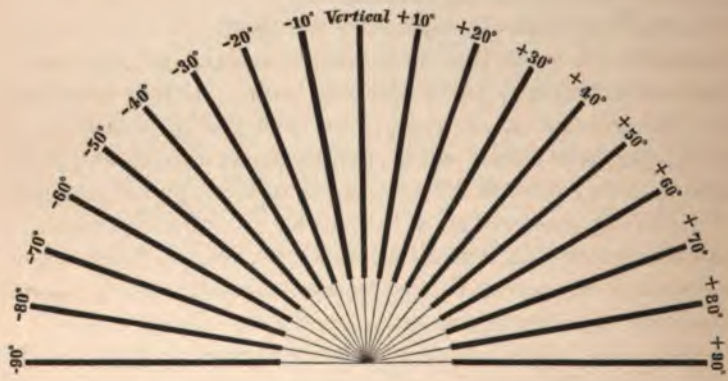
addition of another cylindrical lens of equal focal distance, with its axis parallel to that of the first if it be negative, or perpendicular if it be positive. Thus, it follows that the astigmatism of the eye can be corrected by the addition of a suitable cylindrical lens. The focal distance of the lens required for this purpose defines the degree of astigmatism, the one being inversely proportional to the other. It will also be evident that the degree of astigmatism is the difference of curvature of the two principal meridians.

In the diagnosis of astigmatism the absence of normal acuteness of vision is the first indication of its existence, and this is much more the case the larger the pupil. If this indistinctness has existed unvaryingly from youth astigmatism is the probable cause. From want of distinctness the patient is unable to continue work for any length of time, and if hypermetropia coexist, asthenopia is very likely to occur, because he is compelled to use shorter distances for working, in order to compensate, by the size of the image, for its indistinctness, and consequently accommodative asthenopia will probably follow.

To ascertain the presence of astigmatism, we first test the patient with convex and concave spherical lenses, for astigmatism may exist along with either myopia or hypermetropia. If both of these fail to improve vision or give but slight improvement, then we must ascertain if the indistinctness of vision is due to astigmatism. Various instruments have been invented for the rapid determination of the existence of astigmatism, and the position of the principal meridians, but the simplest is the fan of radiating lines, supplied with Snellen's test-types. These lines diverge at intervals of 10°, and are marked — on the left, + on the right side of the vertical line, Fig. 81 is a reduced copy of them. We place this fan before the patient at a distance of about sixteen feet, make him cover one of his eyes, and arm the other with the spherical lens, which has been found to give most distinct vision. We then ask him if he sees all the lines with equal distinctness, and if he answers in the negative, we ascertain from him which is most and which least distinct. These give the two principal meridians, and are, as a rule, perpendicular to each other.

Then we place in the graduated frame, which is contained in every box of trial lenses, the cylindrical lens corresponding to the spherical one we have selected, so that the line marking its horizontal meridian is at the zero of the scale, and then move the lens round in the frame, until all the lines of Snellen's fan appear equally distinct. We can then read off on the graduated circular frame the positions of maximum and minimum curvature.

FIG. 81.



To determine more exactly the condition of refraction in each of the principal meridians, a stenopaic slit, 1 to 2 mm. broad, should be held before the eyes, in the same direction as the line seen most distinctly, and the condition of refraction ascertained in the usual manner by means of convex and concave glasses. The slit is then to be placed at an angle of 90° with its former position, and the condition of refraction in this second principal meridian determined in the same way. The difference between the conditions of refraction in the two principal meridians shows, as we have already seen, the degree of astigmatism. Since one of the lines is more distinct than the others, the meridian at right angles to it is adapted to the distance of that line, and therefore we have to correct the ametropia of the other meridian. This is done by a cylindrical glass, whose axis is perpendicular to the meridian to be corrected, and which must be added to the correcting spherical lens. We give a concave or convex cylindrical lens according as the meridian to be corrected is myopic or hypermetropic.

The cylindrical glass required is simply the one which gives most distinct vision. We now try the patient with this lens, and if all the lines appear equally distinct his astigmatism is corrected.

We may also ascertain the presence of astigmatism by means of the ophthalmoscope (see p. 234).

Donders has divided astigmatism into simple, compound, and mixed. It is called simple when one of the principal meridians is emmetropic, and is subdivided into simple hypermetropic and simple myopic, according as the ametropic meridian is hypermetropic or myopic. Compound astigmatism exists when both meridians are ametropic but of the same character, and is also subdivided into hypermetropic and myopic. A myopic eye frequently has stronger myopia in the vertical than in the horizontal meridian, and the same is true of a hypermetropic eye. Thirdly, we have mixed astigmatism, when one meridian is hypermetropic and the other myopic. The first two kinds of astigmatism are much more common than the third, which is, indeed, of somewhat rare occurrence.

Simple astigmatism is corrected by a cylindrical glass with its axis perpendicular to the ametropic meridian; compound astigmatism by glasses which are spherical on the one side and cylindrical on the other, and mixed astigmatism by double cylindrical glasses with axes at right angles to each other.

There is an interesting exception to be noted in the case of Thomas Young, the discoverer of astigmatism, who was himself considerably astigmatic. Contrary to the rule, the greatest curvature in his eye was in the horizontal and not in the vertical meridian, and his astigmatism had its seat in the lens and not in the cornea.

Irregular astigmatism exists either in the cornea or in the lens. In the former it is caused by inflammatory processes or by ulcers, which have left the surface of the cornea irregular. Thus, flat or even excavated parts are found side by side with partial ectasies, and frequently each small part of the cornea has a different curvature from the adjacent parts. This is sometimes a greater inconvenience than leucomata, because the retinal image is distorted by irregular refraction at the surface of the eye. No object is seen distinctly, and straight lines appear enlarged and blurred at parts, or show inflections and irregularities of all kinds. This cannot be corrected by any kind of glasses, for the simple reason that it is impossible to give glasses a form similar to the cornea. For the purpose of correcting this irregularity we take a diaphragm with a hole 1 to 2 mm. in diameter, and hold it close to the eye. The patient soon finds out the position in which this stenopaic hole gives most distinct vision. Though the amount of illumination is thus diminished, yet the distinctness is increased, and the advantage so gained is sometimes considerable.

The more common form of irregular astigmatism is found in the lens, and is produced by its structure. The lens is composed of many sectors, whose lines of separation are arranged in the form of a star, which is frequently visible by oblique illumination, and is very pronounced in senile cataract. These sectors differ in curvature, have different foci, and therefore give separate images. These images usually overlap each other, and form only one image, though it is indistinct. So every eye is astigmatic in this way to a certain extent. In other cases many separate images are formed, and thus *polyopia monocularis* is produced. Vulpian specially observed his when looking at the crescent of the moon, while others have observed it by means of a luminous point brought close to the eye.

Donders says that it can be observed by means of a globule of mercury placed on black velvet. This globule acts as a strong convex mirror, and reflects a small image of the source of light. It therefore forms a luminous focus, from which rays of light diverge. If it be brought within a few millimètres of the eye many images, more or less overlapping, can be seen. These are the entoptic images formed by the sectors of the lens.

If one holds his thumb and index finger between him and a source of light, and gradually bring them together, he will see that before contact they form a drop between them, as if they ran into each other. Accordingly, though irregular astigmatism of this kind does not generally influence vision, it may form a very serious obstacle to astronomical observation, for it will be impossible to determine the exact point of contact between bodies. It is of great importance, for example, in transits of Venus, to observe accurately the instants of first and last contact, and with the unaided eye this is impossible. Giraud-Teulon explained the reason of this, and indicated the manner of obviating the difficulty. The boundaries of the two bodies are rendered clear and distinct by looking at them through a stenopaic hole. If a card perforated with a hole half a millimètre in diameter be held before the eye no drop will be formed between the thumb and index finger, as in the case mentioned above.

For the same reason any luminous point, such as a star, appears radiated, and as human eyes have always seen the stars so, it is thus proved that they have always had this irregular astigmatism. There are only two cases known, reported by Humboldt and Landolt respectively, in which the stars were seen as points, and not radiate in form. In these cases either the lenses must have been perfect, or the irregularities of the anterior surface must have been corrected by corresponding but opposite irregularities in the posterior surface.

We have seen that this form of astigmatism is corrected by looking through a stenopaic hole. An image is thus formed on the retina by one section of the lens, or at most by a small portion of it, with approximately the same degree of curvature. The image, however, is less brilliant, on account of insufficient illumination.

Irregular astigmatism changes with alterations in the form of the lens, especially during the formation of cataract. We thus sometimes hear people assert that the stars appear to have longer rays than they used to have, or that they now seem to have satellites, or that the moon appears multiple. The cause of this is to be found in opacities of the lens. After successful operations for cataract irregular astigmatism disappears, and may be replaced by the regular form, resulting from a change in the form of the cornea. This, however, can in most cases be corrected by the use of proper cylindrical glasses.

Though abnormal irregular astigmatism may, as mentioned above, be developed, it remains true that it is most frequently hereditary, and usually derived from one of the parents.

ANISOMETROPIA—DIFFERENCE OF REFRACTION IN THE TWO EYES

The eyes of an individual generally share in the symmetry found in the organs of the body. This symmetry extends to the magnitude of the eyeball, the diameter of the cornea, the colour of the iris, the size of pupil, and even to some congenital morbid abnormalities, such as microphthalmos, congenital cataract, iridemia, and acquired changes of the form of the cornea, as, for example, conical cornea. So also we do not usually find the two eyes differ widely in their refractive conditions.

But while this is the rule it does sometimes happen that the two eyes differ much originally from each other, especially with respect to their refractive powers. Along with this we generally have a want of symmetry in other parts, such as the orbit and the bones composing it, so that the form of forehead and face are also affected.

These differences in refraction may be either congenital or acquired. The various anomalies of refraction are, in fact, combined in all conceivable ways. Thus we may have an emmetropic eye associated with one which is myopic or hypermetropic, or there may be different degrees of myopia or hypermetropia in the eyes, or, again, the one may be myopic, while the other is hypermetropic. When one eye is astigmatic, the other usually corresponds as to its refractive condition, that is, myopia and myopic astigmatism go together, hypermetropia and hypermetropic astigmatism, while with emmetropia, mixed astigmatism is conjoined.

Unequal magnitude or distinctness of the images of the two retinas does not prevent simultaneous vision with the two eyes; on the other hand, they assist each other, so that solidity and distance are more correctly estimated, and such employment as reading or writing also gains thereby. Thus, vision is not disturbed by such inequalities unless by reason of opacity an eye admits much diffused light to the retina. If we place before one eye a weak prismatic glass with the angle turned inwards, there arise double images, which may be got rid of by a distinct movement inwards. This proves that both eyes are taking a share in the work, and that binocular vision really exists. In cases of want of symmetry between the two eyes, the existence or non-existence of binocular vision must first be determined. If it do exist it must be maintained and rendered capable of extension over a greater region. Where there is little difference of acuteness we next ascertain which eye needs the weaker glass for correction. This is generally the eye of more acute vision, and a correcting glass is chosen for it by the ordinary rules. As to the correction of the other, it seems at first sight natural to choose such a glass as will bring its focal point to the same distance as that of the other eye. Further consideration, however, will satisfy you that this rule is by no means to be invariably followed. The influence of habit must be taken into account. Where either hypermetropia or myopia exists in one eye only, the patient has got accustomed to read without spectacles, and binocular vision has been secured without any difficulty. If you supply such a person with similar glasses for both eyes he is quite satisfied, because the relative condition of his eyes is left unaltered. It is thus frequently a disadvantage to render accommodation more equal in the two eyes by providing him with different glasses. Within certain limits a difference of magnitude in the two retinal images is not attended with any appreciable difficulty, especially when the objects looked at are in the same plane. But if difference of magnitude exceeds a certain degree then double vision occurs.

The rule, therefore, is to give similar glasses for both eyes, when binocular vision of eyes of different refraction is acute and easy at any distance without glasses, and the shifting of this distance is necessary. Different glasses can only be allowed in cases in which the difference of refraction is slight. Even then it must only be done after minute examination, so as to make sure that it suits. In this, just as in correcting myopia, very great care must be taken; the eye must on no account be strained, as any straining may give rise to visual disturbances. Every case must be judged *per se*, and not in accordance with any fixed formula. When an eye takes part in binocular vision its function must be maintained, even when it constantly receives very imperfect diffused images.

Metrical System of Numbering Glasses

Within recent years a metrical system of numbering glasses has been introduced. The present generation, however, have been so long accustomed to the numbering by Paris inches, that they are by no means familiar with the new system, the more so as in the standard work on refraction (that of Donders) Paris inches are used; and, besides, provincial opticians, so far from having adopted, do not yet understand the metrical system, so that in ordering glasses the new has to be converted for them into the old system. The usage of ophthalmologists being on this point divided, it is, therefore, necessary to give both systems, and to show their relations to each other.

According to the old, then, the number gave in inches the radius of curvature of the lens. It will be seen by referring to the formula for calculating the focal distance of a lens from its radius of curvature and index of refraction, that, when the index of refraction is 1½, the focal distance is equal to the radius of curvature. Now, this is approximately the index of refraction of spectacles in general use, and therefore the number of a glass gives also its focal distance. In calculations for combinations of glasses we work with their refractive power, which is the inverse of the focal distance. This constantly necessitates operations with fractions, which have proved to many a serious source of trouble, although it is quite conceivable that this, as well as the advantage of the new system, has been somewhat exaggerated. The unit of the old system was a lens of 1 inch focal distance, and it is urged that this is too strong, and, in fact, never found in our trial cases. Also the inch is not a uniform standard, but varies in different countries. Thus, not to mention others, 1 Paris inch = 27·07 mm., while 1 English inch = 25·40 mm. A lens No. 6, therefore, was not exactly the same in England as in France. And, again, the intervals between successive glasses are unequal, varying from $\frac{1}{360}$ between Nos. 72 and 60, to $\frac{1}{18}$ between Nos. 2¼ and 2.

The uniform mètre has, therefore, been adopted as a unit of distance in place of the varying inch, and the unit of the new system is a lens with a focal distance of 1 mètre, and called a dioptric (D). Its refractive power is therefore $\frac{1}{m}$. No. 3 is a lens with three times the refracting power, $\frac{3}{1\,m} = 3$ D; No. 6 has six dioptrics, $\frac{6}{1\,m} = 6$ D.

By thus following the whole numbers a series of lenses is obtained, which has for a common interval one dioptric (1 D). It has been found, however, in practice that we require lenses more feeble than those of 1 m. focal distance, and consequently fractions of a dioptric have been taken; thus, lenses of $\frac{3}{4}$ (0·75), of $\frac{1}{2}$ (0·5), and of $\frac{1}{4}$ (0·25), of a dioptric are found. The quarters of a dioptric have also been introduced between the weak numbers up to No. 2·5, and halves of a dioptric from No. 2·5 to No. 6. In the stronger numbers of the series, on the other hand, the interval of one dioptric is smaller than is necessary, and No. 19 has for this reason been suppressed. Thus, a series of 30 lenses has been obtained, differing by 1 or $\frac{1}{2}$ or $\frac{1}{4}$ of a dioptric. The following table shows the corresponding numbers of the old and new systems.

TABLE

NEW SERIES.	OLD SERIES.
I. Dioptrics.	II. Number. F. in inches.
0·25	—
0·5	72
—	60
0·75	48
—	42
1·	36
1·25	30
1·5	24
1·75	20
2·	18
2·25	16
2·5	15
—	14
3·	13
—	12
3·5	11
—	10
4·	9
4·5	8
5·	7
5·5	6½
6·	6
7·	5½
—	5
8·	4½
9·	4
10·	—
11·	3½
12·	3¼
13·	3
14·	2¾
15·	2½
16·	2¼
17·	—
18·	2
20·	—

a. In the new system the focal distance can be easily ascertained from the number of the glass, the focal distance being the inverse of the refracting power. Thus, if we have a lens of a power of 2 D or $\frac{2}{1\ m,}$ its focal distance $= \frac{1\ m}{2} = \frac{100\ c.\ m.}{2} = 50\ c.\ m.$; 5 D corresponds to $\frac{100\ c.\ m.}{5} = 20\ c.\ m.$

b. The focal distance can, on the other hand, be as easily converted into the number of the lens. Thus, for a lens of 25 *c. m.* focal distance, $d = \frac{100\ c.\ m.}{25} = 4$ D.

c. Since 1 mètre = 37 Paris inches,[1] a dioptric corresponds to a lens of 37 inches focal distance, and therefore $D = \frac{1}{1\ m} = \frac{1}{37}$; 4 dioptrics (4 D) $= \frac{4}{37} = \frac{1}{9}$ of the old system; 6 D $= \frac{6}{37} = \frac{1}{6}$.

d. When we wish, on the contrary, to find the number of dioptrics corresponding to a focal distance expressed in inches, we divide 37 by the number of the glass. Thus, for No. 18, we have $\frac{37}{18} = 2$ D.

e. As the degree of myopia or hypermetropia is indicated by the number of its correcting negative or positive lens respectively; therefore, according to the new system, the several degrees of these anomalies of refraction is also expressed in dioptrics. Thus $H = \frac{1}{20} = 1{\cdot}75$ D; $H = \frac{1}{18} = 2$ D, and $M = \frac{1}{10} = 3{\cdot}75$ D; $M = \frac{1}{6} = 6$ D.

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[1] If English inches are wanted, then 1 mètre = 39·5 inches.

LECTURE XV

THE OPHTHALMOSCOPE

Gentlemen,—This instrument was invented by Helmholtz, in 1854, for the exploration of the deep structures of the eye—viz. the retina, the optic nerve and vessels, the choroid and vitreous. The examination of these parts is impossible to the unaided eye, for, since the dark lining of the choroid absorbs the rays which enter the eye, and thus prevents their reflection, the pupil appears black even when the fundus is directed towards the light. When, however, there is a deficiency of the pigment, as in the eyes of albinos, there is a certain amount of reflection, and so also when there is a tumour within the eyeball (glioma), or a foreign body such as a piece of polished steel on the retina, they are at once visible to the naked eye by reflected light. That the darkness of the pupil, however, is not due to the colouring of the choroid alone will be evident from the fact that the optic disc in some forms of atrophy is white, and yet is not seen by the unaided eye. The reason, therefore, why the deep structures are not seen is not to be found alone in the comparative darkness in which those structures are situated, and in the narrowness of the aperture (pupil) through which they are observed, but also in their depth, for when the retina becomes detached and bulges forward, the retinal vessels are visible.

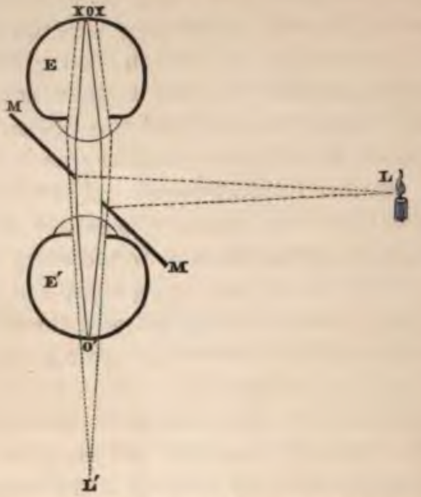
But, allowing these reasons their due weight, the most important part of the explanation still remains. As pointed out by Helmholtz, the structures under examination, being situated behind a dioptric system, are subject to the law of "conjugate foci," and, according to it, luminous rays passing through such a system, follow the same path in coming from the object as they would do in coming from its image, though they proceed in the opposite direction. Thus, when an eye looks at a luminous point placed at a short distance, the rays projected into its interior (incident rays) will meet at a certain point on the retina, and these rays, when reflected by the retina (emergent rays), will, in passing through the eye, have to traverse the same media, and will in their passage undergo the same refraction, so that they meet again at the luminous point, and there form an image of the retina. Hence, an observer cannot see the retina of another person when looking at it obliquely, because in this position only isolated, scattered rays will reach his eye. In order to receive a distinct image of the retina upon his own retina, it is necessary that he place his eye in the course of the emerging rays, and the effect of this would be that, his head being between the source of light and the retina which he is observing, those rays by which he ought to see it will be intercepted.

Brücke and Cuming, in 1847, succeeded in obtaining a red reflection of the fundus by means of a lamp placed in front of the patient's eye, the observer looking at the same time from behind a screen. Afterwards D'Erlach observed that, while standing before a lamp and looking at the eye of a friend, he saw an image of the retina of his friend's eye formed upon his spectacles. Helmholtz profited by this observation, and turned it to practical account in the invention of the ophthalmoscope, by which we are enabled, not merely to obtain a red reflection, but to examine minutely all the deep structures.

The theory of the ophthalmoscope, like that of almost all great inventions, is so simple that it seems quite astonishing that our predecessors should so long have remained satisfied with mere guess-work with regard to the condition of the deep structures of the eye. The method of observation recommended by Helmholtz was to place the lamp at the side of the patient, and reflect its light into the eye by means of a plane mirror with a central opening, through which the observer could look. The mirror held obliquely before the patient's eye reflects into it the light of the lamp, and the eye of the observer being placed in the direction of the emerging rays, without cutting off the rays from the source of illumination, was able to see the fundus of the patient's eye.

In Fig. 82, E is the eye under examination, E′ the eye of the observer, L the source of light, and M M the mirror. The

FIG. 82.[1]



rays of light from L are reflected by the mirror and fall upon the patient's eye, as if they had come from L′. The rays of light which emerge from the eye E, after reflection from the retina X X, do not all fall upon the mirror and undergo reflection to L, but a portion of them pass through the central aperture and reach O′ on the retina of the observer, where they form an image of O, the fundus of the patient's eye.

The first ophthalmoscope of Helmholtz had a plane mirror, and was rather complicated. Rüet improved upon this, by introducing in place of the plane mirror a simple concave mirror with a central aperture. The advantage of the concave mirror is that it concentrates the light, and thus gives a more powerful illumination.

In many cases, however, a feeble illumination is to be preferred, especially when by reason of inflammation of the deep structures the patient's eye cannot bear a strong light, or, when the pupil is much contracted, by a bright light. In such cases the plane mirror may be adopted with great advantage. Rüet's instrument was a large fixed one, but the ophthalmoscopes now in use are much more simple in character. They are all based on the same principle, but differ in the size of the mirror, and the lenses, in the attachment of the lenses behind the mirror, and in portability, while each one is well adapted for its purpose. I used Coccius' and Desmarres' pocket ophthalmoscope for a number of years, until I found that beginners require an instrument of clearer definition. The instrument which I am in the habit of recommending to my pupils was first made for me by Nachet, but is now made by Crétès, of Paris. My ophthalmoscope for the study of refraction differs from the simple one by the addition of discs, one with concave, and the other with convex lenses[1]

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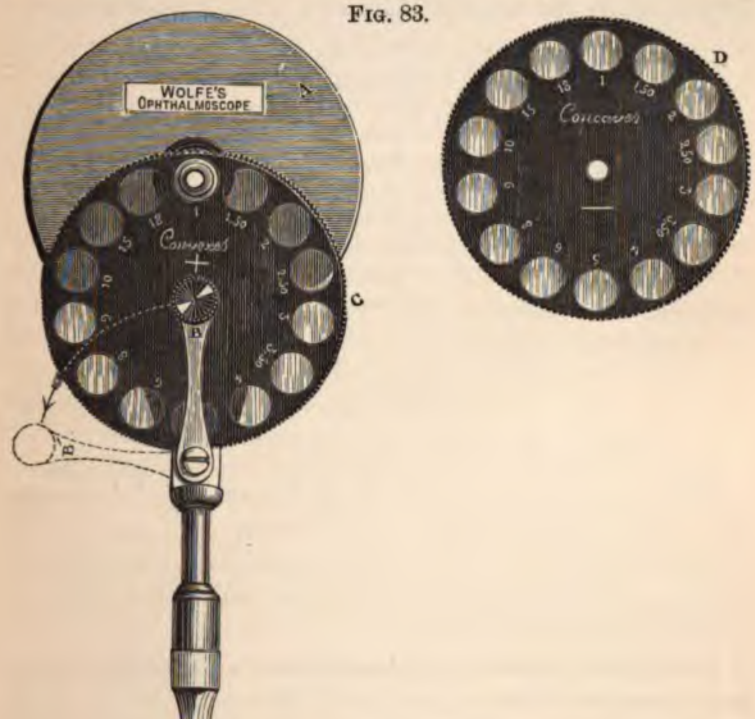
[1] The ophthalmoscope figures are after Landolt.

FIG. 83.



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[1] Both instruments are sold by Weiss & Son, London; and Hilliard, Glasgow.

In Fig. 83, A is the mirror, C the disc of convex and D of concave lenses, B is the handle, with a centre pin for fixing the disc, which is easily lifted, and B is then turned round into the position B′, so that the disc can be replaced by the other or removed for cleaning. Every lense as it comes round to the centre hole is fixed with a ratchet.

It consists of the following parts:

1. A concave mirror of 25 cm.$=9\frac{1}{4}$ inches focal length.

2. An objective lens 50 mm.$=1\frac{3}{4}$ inch (English) in diameter, of 16 D$=2\frac{1}{4}$ inches focal length.

3. Two discs, one with convex, the other with concaved lenses. Each disc contains 14 lenses of the following numbers:

1 D = 36
1·50 D = 24
2 D = 18
2·50 D = 15
3 D = 12
3·50 D = 11
4 D = 9
5 D = 7
6 D = 6
8 D = $4\frac{1}{2}$
9 D = 4
10 D = $3\frac{1}{2}$
15 D = $2\frac{1}{2}$
18 D = 2

Each lens is 6 mm. in diameter=3 lines.

The advantages of these lenses is that the ophthalmoscope can be used as an optometer for trial lenses.

For taking ophthalmoscopic sketches of the inverted image and for clinical demonstrations, Liebreich's fixed ophthalmoscope is the most convenient.

The different methods of ophthalmoscopic examination may be described as follows:

EXAMINATION BY FOCAL ILLUMINATION

This is, strictly speaking, not an examination by the ophthalmoscope, for in it we use the concave lens alone, without the mirror. It is conducted in a dark room, and the patient is placed on a low chair, so that his eyes are on a level with the chin of the observer, who sits close to the patient on his right hand. His face is turned towards a gas lamp with an Argand burner placed on the table, and the observer, holding the lens in his right hand, places it at its own focal distance from the eye to be observed, and by means of it throws a pencil of light through the cornea. He can thus examine that membrane, and see if there be a foreign body impacted, or if there are any opacities in it, and also measure the depth of any inflammation which may be present, although this is better done by means of a duplex lens or by Donders' improved ophthalmo-microscope. To explore deeper, the observer may dilate the pupil by atropine, although a little practice will enable him to dispense with mydriatics. By making the patient rotate the eyeball in every direction the observer will, by a little manœuvre, be able to direct a pencil of light through the pupil, and by so lighting up the lens ascertain whether there be the commencement of cataract. He will also be able to explore the vitreous, and observe if there be hæmorrhage there. When these parts are in a healthy condition the whole field presents a black appearance. Focal illumination is sometimes better done by clear sunlight, for if the patient be put before a window in clear sunshine, and the light admitted through a slit in the shutter, one can see better than by artificial light.

Look at this case of detachment of the retina, for instance, on which we might have been tempted to operate, but we deemed it prudent not to interfere, because not only was the contraction of the visual field out of proportion to the extent of the detachment, but also the ophthalmoscopic mirror did not enable us to define the exact conditions present. On examining the eye before a window with a lens, and by having the eyeball rotated downwards and inwards, we can distinctly see a bloody membrane shining through the detachment, and as the case is thus proved to be one of apoplexy of the choroid we refrain from interfering.

You will, however, bear in mind that only such cases as the one just mentioned and opacities of the cornea may with safety and advantage be subjected to this mode of examination. You should never use sunlight for lighting up a transparent cornea or diseased deep structures, as it might cause some retinal mischief, and it is for this reason that it is necessary to use artificial light in ophthalmoscopic examinations, for although it does not show the natural colour of the retina, that disadvantage is counterbalanced by its safety.

EXAMINATION OF THE VIRTUAL OR ERECT IMAGE

In this method of examination we use the mirror alone for lighting up the fundus, since the dioptric system of the eye itself serves as a magnifying glass, through which the enlarged image of the fundus is reflected.

Position of the patient.—The room having been darkened, the patient is placed on a low chair, so that the eyes are on a level with the chin of the examiner; the gas-lamp is placed on the same side as and on a level with the eye to be examined, but so as to throw the cornea slightly in the shade. We sit in front of the patient, and, holding the ophthalmoscope in the right hand, look through the central hole, turning the instrument slightly to the lamp, in order to catch the rays, which are thus concentrated and thrown into the interior of the eye. The patient is then told to look slightly upwards, downwards, and in all directions, while the observer keeps at a distance of about six or eight inches from him. During these movements we ascertain if there is any opacity of the vitreous, for if there be we shall see black spots or grey flocculi in its interior, or silvery flakes or globules of cholestrine passing rapidly through it. Should there be detachment of the retina it will manifest itself by the interposition of a grey, opaque body, upon which will be seen the ramifications of blood-vessels (Chromo., Pl. VIII, figs. 1 and 2). If, on the other hand, the media be healthy, we see a clear, bright-red reflection. Directing the patient to look now towards the further end of the room and slightly inwards, and keeping still at the same distance from him, we observe the optic disc coming into view. As it is white or pinkish white, and thus different in colour from the rest of the fundus, it is easily recognised. We then bring the mirror within about two inches or less of the patient's eye, leaving in fact only such an interval as is necessary for the concentration of the luminous rays, and see an erect image, magnified about fourteen diameters, of the optic disc and blood-vessels. The image is enlarged, because the luminous rays coming from the fundus have to pass, not through air, but through the refractive system of the eye, which, as we have already seen, acts as a magnifying glass.

In bringing the mirror close to the eye our own accommodation must be relaxed, and also that of the patient must be at rest. Indeed, it is an essential condition for examination of the erect image that the accommodation of the eye, both of the examiner and of the patient, should be completely relaxed, for when the ciliary muscle is active a meniscus is added to the lens, and a new factor thus introduced. The emmetrope and hypermetrope, therefore, must accustom themselves to look through convex lenses at objects situated at the focus of the lens and practise the habit of bringing their eyes to a condition of parallelism. This relaxation of accommodation is the object we have in view when we order the patient to look to the further end of the room, and the end may be still more certainly attained by using a few drops of atropine. On the part of the observer, again, his eye is relaxed in order to adapt it for the parallel rays which emerge from an emmetropic eye, and to do this he must try to stare as if he were looking to an infinite distance, because an object situated behind a dioptric system is the same to his emmetropic eye as if it were situated at an infinite distance. This power of putting one's refraction at zero requires some practice, and if you are unable to control your own accommodation, and consequently find it active when looking at near objects, you must neutralize your refraction by putting a weak concave lens behind the mirror.

We have assumed that both your own eye and that of the patient are emmetropic; but if yours be myopic or hypermetropic, your ametropia must be corrected by wearing your own glasses, or (which amounts to the same thing) by putting behind the mirror the number of concave or convex lens required to render your eye emmetropic.

The image which we thus see through the mirror is called the *virtual* or *erect* image.

But, it may be asked, if images formed by rays which have passed through a refracting apparatus are, as we have seen, inverted, why is this image virtual or erect? The reason simply is that, in order that an image may be inverted, it must be formed by the convergence of luminous rays, whereas rays emanating from an emmetropic eye are parallel, and, therefore, form an erect image. For one emmetropic eye to see the fundus of another such eye it is therefore sufficient that the latter be simply lighted up by means of a mirror applied close to it in the course of the emerging rays. Objects at the fundus are then seen in their erect position, as indeed all objects are when placed at the principal focus of the lens through which we look at them.

Although the examination by this method does not yield a distinct and well-defined image, since it is too large in proportion to the pupil, even at its maximum dilatation, still it ought never to be neglected, as the details of the retinal image can be better studied by it than by the inverted image, upon which, nevertheless, you must chiefly rely for your diagnosis.

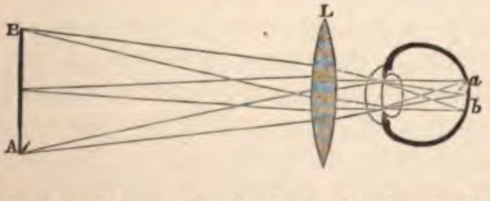
EXAMINATION OF THE REAL, INVERTED IMAGE

In this method of examination we use the refracting media of the eye as the object-glass of a telescope, and make it project a real, inverted, aërial image of the fundus, which, though smaller, being only about five times the size of the disc, is more distinct and better defined than the erect image. As the means of producing this image we employ the mirror to illuminate the fundus and the biconvex lens, which we interpose between the retinal image and our own eye.

The patient is placed in the same position as for the erect image. The lamp is put on a level with the patient's eye, a little behind it and on his left side, for the examination of either eye. The light is reflected by the mirror in the manner already described for the erect image, but on obtaining a red reflection of the fundus, instead of approaching the eye, you remove your head to a distance of about fourteen inches from it. On directing the patient to look at your right ear, if his right eye be under examination, or to your left ear, in the case of the left eye, so as to turn the axis slightly inwards, the optic disc is brought into view, and can easily be recognised by its peculiar pinkish-white reflection. You then interpose the biconvex lens, held in the left hand in front of the eye under observation, and at a distance equal to its own focal length from the cornea. Instead of putting your ring and little fingers upon the patient's brow, as is generally recommended, you ought to hold the lens between your thumb and index finger, with the hand unsupported, for you are thus able to move the lens about much more freely than when the hand is supported. If the image appears indistinct it must be owing to the fact that your eye is not accommodated for the proper distance, and you must then withdraw your head a little further, whereby you add to your refraction, or call in the aid of your ciliary muscle to adjust your accommodation, or put a convex lens behind the mirror. Indeed, the practice of putting a convex lens behind the mirror for the examination of the inverted image is of great service, because it saves fatiguing your own accommodation, and also because the image is thereby much enlarged.

The image of the optic disc and blood-vessels which is thus seen is called the *real* and *inverted* aërial image, for although it appears as if situated within the eye, it is in reality an inverted image, formed in the air between the observer and the biconvex lens, at a distance corresponding to its focal length. In Fig. 84 L is the biconvex lens, by means of which is formed an inverted image (B A) of the fundus (*a b*) of the eye under examination. On concluding your examination of this part direct the patient to look through the hole in the mirror, and the region of the macula will come into view.

Fig. 84.



LECTURE XVI

NORMAL APPEARANCE OF THE FUNDUS

GENTLEMEN,—The retina, choroid, optic nerve and vessels, and the sclerotic all contribute to the formation of the retinal image. The retina is perfectly transparent and colourless, and, therefore, the bright-red reflection seen by the ophthalmoscope is not due to it, but to the choroid, which varies in colour according to the amount of pigment contained in it and in its epithelium. If the choroid be only slightly pigmented, both in its epithelium and stroma, as in the case of fair-haired persons, the choroidal vessels, even to their finest ramifications, are distinctly visible against the background of the sclera. But when the choroidal stroma is rich in pigment, while the epithelium has but little, and is therefore transparent, the image of the fundus is very different. The large vascular trunks lying in the outermost layers and their finest branches are in such cases hidden by the pigment of the stroma, while the vessels of medium size remaining visible form a distinct network, whose meshes, called vascular spaces, appear almost black on account of the darkness of the pigment of the stroma. But if, on the contrary, the choroidal epithelium is densely pigmented, and the stroma but slightly so, very little of the latter can be seen, owing to the great absorption of the light by the former. In blue eyes, therefore, the fundus is bright and red, in darker eyes and in persons with dark hair it is of a deeper tint, and in negroes it becomes of a dark-blue colour (see Chromo., Pl. I).

By turning the eyeball slightly inwards through an angle of 15° or 20° the optic disc can be seen. Its form is either round or oval, and only very rarely angular. At first sight it appears of a pinkish-red colour, but closer inspection shows that it has a white or pale centre, which is sometimes hollowed out, for the bundles of nerve-fibres contained in the optic nerve, having arrived at their intra-ocular end, form a bend to pass into the nerve-fibres of the retina.

When magnified with a convex lens of three inches, the network of connective tissue can be distinctly seen by its brilliant white colour, whilst the bundles of nerve-fibres appear as bright greyish dots.

This central depression may be so deep as to present a difference of level from the optic nerve, and then it is called "physiological excavation." The sides of this excavation usually form a gentle slope, but occasionally there is an abrupt descent with steep, overhanging walls. It is, however, of great importance to distinguish between this depression and the glaucomatous excavation. The distinction between them is that, the former never extends over the whole disc, while in glaucoma it extends over the whole disc, and the central vessels either run from the hollow, or are displaced laterally against the walls of the excavation (see Chromo., Pl. II).

Outside this white centre there is a zone of a red tinge, due to the presence of capillary blood-vessels. Beyond it, again, there is a white ring, more distinct on the one side than on the other, and of a breadth varying in different individuals. Increase of width gives it the crescentic appearance, which is seen in myopes. This white ring is formed by the edges of the scleral and choroidal openings, for, as these two apertures do not quite coincide with each other, the choroidal ring being larger in diameter than the sclerotic opening, the margin of the latter is left uncovered by pigment, and shines through the transparent nerve-fibres. When accompanied by diminution of vision it may be the result of the commencement of serious nerve changes; but when it is so, its border is dim and ill-defined, while when physiological its border is quite sharp in outline.

The blood-vessels emerge from the central portion, and consist of four large branched arteries, with the same number of veins. Two of each pass upwards and two downwards, to be distributed over the retina, which also receives a variable number of smaller branches given off by the principal trunks. The arteries are of a bright-red colour, and straighter in their course; the veins are darker, more sinuous, and of greater calibre.

Venous pulsation is a frequent physiological phenomenon in the larger veins, where they bend to sink into the optic nerve, or on the margin of the physiological excavation. This symptom is explained by Donders as follows :—" The augmented pressure, under which the blood runs into the arteries, is partially propagated to the vitreous body before it has had time to extend through the capillaries into the veins. The pressure of the blood in the veins decreases from the capillaries towards the heart, and hence the augmented pressure in the vitreous meets with the least resistance from the principal venous trunks, just at the point where they leave the interior of the eye. This portion of the veins is therefore compressed, and its contents quickly forced out, while the blood coming from the capillaries is dammed up on the distal side of the compressed portion. At the end of the heart's systole the augmented pressure in the arteries and that in the vitreous intermit, the compression of the veins ceases, and the obstructed blood flows rapidly away."

This venous pulsation may be produced simply by laying the finger on the normal eye. E. v. Jaeger has also shown that arterial pulsation may in like manner be produced in the arteria centralis by pressure on the eyeball. But when this arterial pulsation appears spontaneously it shows the presence of intra-ocular pressure, and is thus characteristic of glaucoma, although it may also occur in aortic regurgitation.

As you may find some pigment scattered over the disc, you ought to know that it is a congenital and physiological condition. Chromo., Pl. IV, fig. 2, represents the case of a person who was in a railway collision, and claimed damages for injury done to his eyes. Examination proved it to be a simple case of posterior staphyloma, with pigment upon the disc. In this case the pigment was nearly symmetrical in both eyes. There may also be sometimes noticed in one of the blood-vessels, at its origin or termination in the disc a small, dark spot, which might be mistaken for an embolus, but it has no such significance. The vessel here passes backwards through the transparent nerve-fibres, and it is solely to this that its peculiar appearance is due.

APPEARANCE OF THE MACULA LUTEA

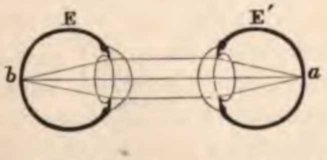
The centre of the macula is very prominent on account of its red colour. The fovea centralis is recognised as a small red disc, whose centre often appears as a whitish spot, round or hook-shaped. The red colour of the fovea centralis, as well as that of the fundus in general, is due to the blood of the choroid, while the darkness of the fovea is owing to its dense pigmentation.

THE STUDY OF REFRACTION BY MEANS OF THE OPHTHALMOSCOPE

When Helmholtz introduced the ophthalmoscope, he pointed out that we can not only explore thereby the deep structures of the eye, but that we can also determine its refraction, and Mauthner systematized the study. The advantage of this method of diagnosis is that it makes us entirely independent of the statements of the patient, which in eye affections are generally misleading. In the case, also, of children or illiterate perons, who cannot be tested with the types, or in cases in which amblyopia and some anomaly of refraction coexist, it becomes rather a complicated question how much of the dimness is due to disease, and how much to a state of abnormal refraction. In such cases the ophthalmoscope is of special importance.

From what has been already said of the theory of the ophthalmoscope you will see that when your emmetropic eye, adapted for parallel rays, is applied closely to the patient's eye, and you can see the retinal image, you have in this sufficient proof that the rays emanating from his eye are parallel; so also, in seeing the erect image, you have at the same time made out that his refraction is normal, or, in other words, that he is emmetropic. Thus, in Fig. 85, E is the emmetropic eye under

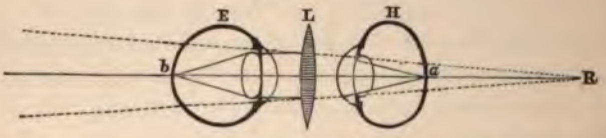
FIG. 85.



examination. Rays emerging from the retina *b* being parallel, are, when refracted by the emmetropic eye of the observer (E′), brought to a focus, and form an image upon his retina at *a*.

When, however, the patient is either hypermetropic or myopic, you will not see any retinal image on approaching the eye with the mirror; for in a hypermetropic eye, since the refractive power of the eye is too weak, and the focus consequently situated behind the retina, emergent rays will also be insufficiently refracted, and will, therefore, not be parallel as they must be in order to form an image on your retina. They are in fact divergent, and to receive the retinal image of such an eye you must increase the refraction. Thus in Fig. 86, if H be the hypermetropic eye of the patient and E the emmetropic eye of the observer, since rays incident on H must be convergent in order to form an image on the retina at *a*, because parallel rays would be focussed at R behind the retina, it follows that rays from *a* will on emerging be divergent as shown by the dotted lines, and can therefore form no image at B. In order to get an image, we must either interpose a convex lens to render the rays parallel or else withdraw the head until the eye E is at some distance from H. In either case, then, we shall have an image of the fundus *a* formed on the retina *b*. You therefore withdraw your head to such a distance from the eye of the patient, as to place your eye at the conjugate focus. In this position, however, you will not see a distinct retinal image, but only the retinal vessels, because at a distance from the pupil the field of vision becomes so contracted that a small object, such as even one blood-vessel, fills up the whole area. The distance to which you must remove your head corresponds to the distance to which the focus of this hypermetropic eye is removed behind the retina. Whenever, therefore, you approach an eye with the mirror and find that

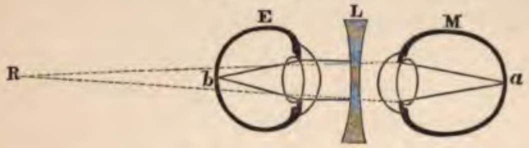
FIG. 86.



no retinal image is visible, you will judge at once that the eye is ametropic, and will then gradually withdraw your head until you begin to notice the delineation of some of the blood-vessels of the image. The image you will see is erect, as you may easily prove by moving your head to either side, when you will see that the blood-vessels follow your movements.

But if, on the other hand, the eye of the patient be myopic, as parallel incident rays converge to a focus in front of the retina, so also the emergent rays from the retina converge

FIG. 87.



to its punctum remotum. Let E (Fig. 87) be the emmetropic eye of the observer, M the myopic eye under examination and R its punctum remotum. Then, as the rays from R fall upon the retina at *a*, so rays proceeding from *a* will converge to R. In order to make these latter rays converge to *b* and so produce an image on the retina of the observer, it is necessary to interpose a concave lens L, whose focal length is equal to the distance of R, and thus render the converging emergent rays from the eye M parallel before they fall upon E. Or you may see the image of the retina A by withdrawing your eye E to some distance, viz. to the point R to which the rays converge. The image which you see at this point is not, as in the other case, erect, but inverted, for on moving your head to either side, upwards or downwards, the image moves in the opposite direction.

In ophthalmoscopic examination, then, if you remember that the rays emanating from an emmetropic eye are parallel, because such an eye is adapted only for parallel rays; that the rays coming from a hypermetropic eye are divergent, because they are insufficiently refracted by its dioptric system; and that those emerging from a myopic eye are convergent, its refractive apparatus being too strong, you will at once comprehend why an emmetropic cannot see the image of an ametropic eye close to its cornea, and why the image of the one, seen at a distance, is erect, while that of the other is inverted. This is according to the principles of optics referred to in a former lecture. The emmetropic eye is represented in Fig. 68 (p. 180), where rays of light diverging from the principal focus (F) emerge parallel to the axis. The course of the emergent rays from a hypermetropic fundus is represented in Fig. 71, where rays falling upon a convex lens from P, a point in the axis nearer to the lens than the principal focus, take a divergent course, and the focus is virtual. The myopic eye, on the other hand, is represented in Fig. 70, where rays emanating from F′, a point further removed from the lens than the principal focus, converge to the conjugate focus (P). There is, therefore, no image visible at F′ but convergent rays, while at the conjugate focus (P′) there will be a real image of P.

Having thus made out, by means of the mirror alone, that the eye is either hypermetropic or myopic, you next seek to ascertain the degree of the anomaly. On finding in the one case, from its following your movements, that the image is erect, you put the disc of convex lenses behind the mirror, and approach the eye as for the examination of the erect image, and by revolving the disc find out the number of the convex lens, by means of which you see the erect image most distinctly. As a test object it is best to use one of the fine vessels of the retina, running from it to the macula (arteria macularis superior. Magnus). The focal length of the convex lens indicates the degree of hypermetropia. Thus, if an emmetropic observer distinctly sees the fundus of a hypermetropic eye with a convex lens of twenty inches focal distance, the abnormal eye needs such a lens to render its emergent rays parallel, so that the rays must without the lens have been proportionately divergent before reaching the cornea; so that as the degree of hypermetropia corresponds to the number of the correcting lens, so does the convexity of the correcting lens correspond to the degree of hypermetropia.

We determine in like manner the degree of myopia by the strength of the concave lens required by the emmetropic eye of the examiner in order to see the retinal image. Thus, when at a distance from the eye you see that the image is inverted, moving in a direction opposite to the motion of your head, you put the disc with the concave lenses behind the mirror and approach the eye. By revolving the disc you find the number of the concave lens, by means of which you see distinctly the erect image, and the number of this lens indicates the degree of myopia; for when an emmetropic examiner requires the aid of a concave lens to see the fundus of an eye, that eye is myopic, since the luminous rays which have been rendered parallel by the concave lens must have been convergent before reaching the lens, and therefore must have come from a myopic eye. And the number of the lens indicates the degree of the myopia of the examined eye, for if an emmetropic eye requires a concave lens of ten inches focal distance to see the fundus of another eye, that other must, in order to project parallel rays, have an excess of refraction exactly corresponding to the negative lens of ten inches focal length required to neutralize it.

A very useful and ingenious instrument, called the ophthalmoscoptometre, has been invented by M. Warlomont. When the pupil is dilated with atropine the state of refraction can be easily ascertained by means of this instrument. It is used in Belgium for the examination of recruits, and is made by Roulot of Paris.

Mr Teale has suggested a new method of determining the degree of hypermetropia by means of the ophthalmoscope. According to it, the ophthalmoscope is held about fourteen inches from the eye—the distance for observing the inverted image. By the trial lens the observer ascertains what form of lens, held close to the patient's eye, would restore the hypermetropic fundus to the appearance of an emmetropic eye. For this method he claims the following advantages:

1. It was rarely necessary to paralyze by means of atropine the accommodation of the patient, in order to find out the full degree of simple hypermetropia.

2. It did not call upon the observer either to paralyze or suspend his own accommodation.

3. The degree of hypermetropia can generally be accurately determined at one interview.

There is another advantage in this method, which appears to me even more important than those mentioned by Mr Teale, viz. that it saves us coming close to the patient's face.

HOW TO ASCERTAIN ASTIGMATISM BY MEANS OF THE OPHTHALMOSCOPE

In describing the examination of the eye by the ophthalmoscope we have up to this point always regarded the patient's eye as a magnifying glass of regularly curved surfaces, but in cases of astigmatism we have to deal with eyes which have different refractions in their different meridians, and must therefore now discuss the distinctive features of the image of the retina as presented to us by the ophthalmoscope.

When we look, then, through an astigmatic eye at its retinal vessels we are in the same condition as when looking at a figure with radiating lines through a cylindrical lens. The lines perpendicular to the meridian for which the eye of the observer is adapted will therefore alone appear distinct. In looking at the disc with the mirror alone, if it be round in form it will appear oval, with its longer axis parallel to the meridian of greatest curvature, which is generally in the vertical direction. In the examination of the inverted image the appearance is exactly reversed, that is to say, a round disc appears elongated in the horizontal direction. But as the optic disc itself has frequently an oval form, elongated more generally in the vertical than in the horizontal direction, we must form our diagnosis of the existence of astigmatism by comparison of the erect with the inverted image.

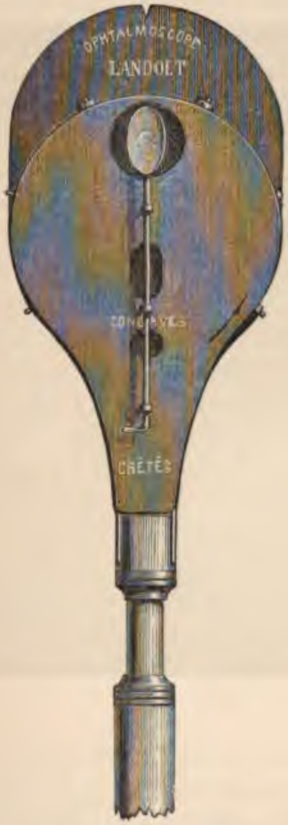
When we find that the erect image presents a disc elongated in a vertical direction, while the inverted image, on the other hand, shows an elongation of the disc in a horizontal direction, the existence of astigmatism is demonstrated. In the examination of the inverted image you must use a strong convex lens of three inches focal distance. It is of importance that this lens be held straight and not obliquely, and also that it be kept in the centre, so that the images from its anterior and posterior surfaces may cover each other, and if possible be nearly in a line with the optic disc.

SIZE OF THE OPHTHALMOSCOPIC IMAGE.

Prof. Landolt has succeeded in measuring the enlargement of the ophthalmoscopic image,[1] and a brief outline of his valuable researches may be of some interest here.

The magnified image of the retina is projected to a distance of twenty-five to thirty centimètres, this distance of projection or distance from the eye at which the image is measured being

FIG. 88.



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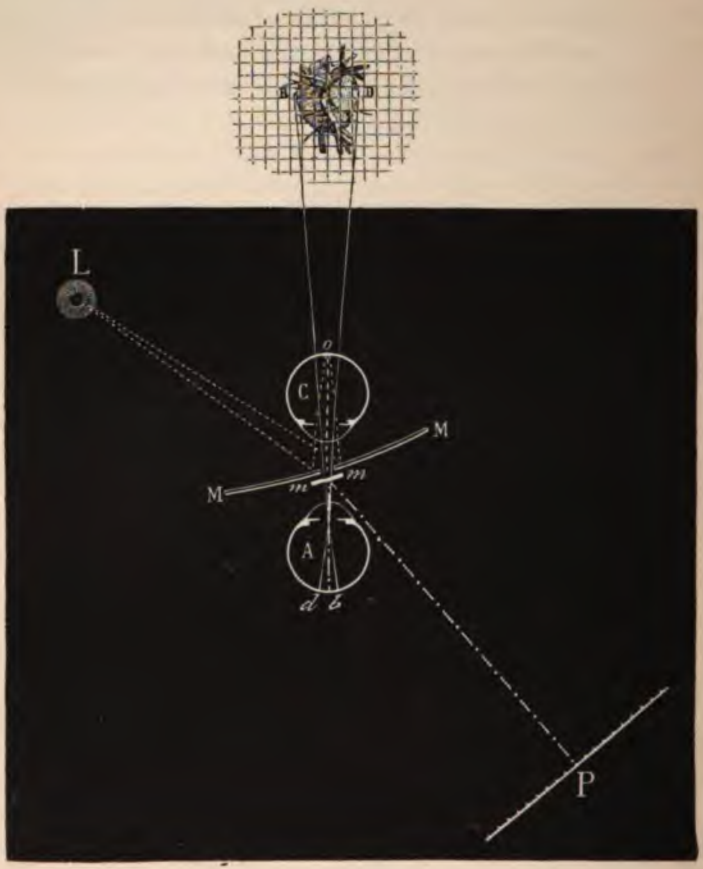
[1] 'Sur le grossissement des images ophthalmoscopiques.'

a purely arbitrary one, chosen as a standard for the purpose of comparison.

I. For the *erect* image two methods may be employed :

Fig. 89.



(A.) In the *methode à double vue*, he places at a distance of thirty centimètres, behind the patient's head, a plane vertical surface divided into squares, one millimètre in size. While examining the right eye of the patient with the ophthalmoscope, he directs his left eye to the divided surface, and is able to see the image of the retina projected there. The number of squares it then occupies gives the apparent size of the image.

(B.) The *methode à reflexion* is as follows:—Behind his ophthalmoscope (Fig. 88) there is placed a very small, thin mirror, movable round a vertical axis, and partly deprived of its silvering by being scored in all directions. The divided plane surface is in this method placed at the side of, or somewhat behind, the experimenter's head. On looking through the ophthalmoscope at the retina, and inclining the small mirror at such an angle that it shall reflect the divided surface, it is found that the ophthalmoscopic image appears to be divided into squares, each of which is of course one millimètre in size.

Fig. 89 will make this clear. L is the lamp, P the projected divided surface, M M the ophthalmoscopic mirror, *m m* the small mirror, A the eye of the examiner, C the eye under examination, and B the retinal image, as seen by this method.

If the image occupies 20 mm., while the real size of the object is 1 mm., then, manifestly, it is enlarged twenty times. Unfortunately, however, there is no test object to be found in the fundus, as even the optic disc varies in size. We can, therefore, only get an approximation to the truth, which, nevertheless, may be very valuable in practice.

Landolt has arrived at the following results:—

1. In an emmetropic eye, when examined by the erect image, the enlargement is twentyfold.
2. The degree of enlargement is less for a hypermetropic and greater for a myopic eye, and is in proportion to the degree of ametropia.
3. The enlargement is less in hypermetropia of curvature than in axial hypermetropia.
4. The enlargement is more considerable in myopia of curvature than in axial myopia.

II. The measurement of the *real, inverted* aërial image is effected more simply. Near one end of a cylinder, such as that of Liebreich's demonstrating ophthalmoscope, there is fixed a convex lens of, say, 55 mm. focal length. The other end of the tube, to which the observer applies his eye, has an opening at the side to allow light to fall on the ophthalmoscopic mirror, which is placed there. The inverted image is produced between the lens and the mirror, and by means of a movable diaphragm, divided into squares and placed at this spot, we find by measurement the distance of the image from the eye of the observer, and note the number of squares which the image occupies.

From the data so obtained, we can also calculate the actual size of the object by the formula $x = \frac{F}{g''}$, where F = focal distance of the lens, and g'' = distance of the nodal point of the eye examined from its retina. This distance is 15 mm. in the emmetropic eye, while it is greater in the myopic, and less in the hypermetropic eye, the difference being easily found for each case of ametropia. Let y = the difference between the emmetropic and the ametropic eye, then y will always be equal to 300 mm., divided by the focal distance of the lens which corrects the ametropia. The value of y must be added to 15 mm. in the case of myopia and subtracted in that of hypermetropia.

LECTURE XVII

CYCLITIS

GENTLEMEN,—Before proceeding with the study of the structures exhibited by the ophthalmoscope, we shall first consider the ciliary region, which occupies an intermediate position. Cyclitis is a term introduced by v. Graefe to designate an inflammatory process of the ciliary body. On account of the continuity of the iris, ciliary body, and choroid, no distinct line of demarcation can be drawn between the inflammation of these parts. An inflammatory process setting up in any of these tissues can hardly be limited, but does generally extend to and involves the rest. After a severe attack of iritis, for example, the vitreous remains cloudy, showing that choroiditis had been present, and, on the other hand, inflammation of the choroid, even in the chronic form, generally leads to adhesion of the iris. Yet the ciliary circle, *i. e.* the region round the cornea, the place of meeting of the vessels and nerves for the nutrition of the eyeball, is of sufficient importance to deserve special attention.

Although inaccessible to the naked eye or to the ophthalmoscope, yet we can diagnose without difficulty the existence of some inflammatory processes confined to that region. In cases of iritis or irido-choroiditis, when accompanied with tenderness on pressure upon the ciliary circle, we may conclude that the ciliary body is involved. But cyclitis may exist without marked change in the iris or choroid.

The disease sets in with slight photophobia, hyperæmia of the conjunctiva, and injection of the deep vessels at the margin of the cornea, without any appreciable change in the iris or inflammation of the choroid, the inflammatory process being manifestly confined to the ciliary body. This process may even develop into the suppurative stage without iritis being present. When this takes place, pus is precipitated into the anterior chamber after a few days of slight uneasiness of the eyeball. In the absence of iritis or choroiditis there is no doubt that this pus comes from the ciliary body.

Cause.—Cyclitis is brought on by grief and night watching, scrofulous cachexia, suppressed menstruation. Suppurative cyclitis, in children especially, is the sequela of scarlet or typhoid fever.

Treatment.—Warm fomentations and atropine, blisters at the temple, laxatives, and tonics. As soon as the pus accumulates it should be removed by paracentesis.

CASE.—Dr Key, of Montrose, consulted me in the case of a lady, aged about 60, who had just lost her husband, and who, although she had never previously been troubled with tender eyes, felt some uneasiness in the left eye. The conjunctiva became hyperæmic, the ciliary circle injected, tender to the touch, and a quantity of pus became visible in the aqueous chamber. Solution of atropine and warm fomentations were applied along with blisters to the temple, and the administration of laxatives and tonics. The pus was absorbed in the course of a week, and sight restored. In the course of twelve months, however, she had other two attacks, which were cured by the same treatment. I am, however, quite certain that paracentesis, for removing the pus as soon as it accumulates, is the best and the most expeditious treatment. But for the extreme timidity and nervousness of the patient, which made her shrink from the idea of an operation, she might have been saved from the subsequent attacks. I have already mentioned to you, in connection with hypopion, the disadvantage which the tissues labour under when pus is allowed to be absorbed, and, it may be, carried from one place to another. There is always a tendency to leave behind a weakly condition of the organ, contrasting unfavourably with the fresh appearance of the eye after the pus has been removed by puncture.

INJURY OF THE CILIARY REGION

We have already seen the effects of irido-cyclitis in producing *sympathia*, and have only to notice now the other alternatives.

When a foreign body penetrates the ciliary region, without remaining there, the eyeball either becomes soft or suppurates.

CASE 1.—Ellen D— has just come to the institution (July, 1881), recommended by Dr Adams. A fork had penetrated her eye at the junction of the cornea with the sclerotic. There was very little pain in the eyeball; the lens was not dislocated, nor did it seem to be opaque. Vision was entirely abolished, and the eye was exceedingly soft (T = − 3).

CASE 2.—Jane M—, had had her eye struck with a steel pen at the ciliary region. Violent pain set in the same night, and next morning the eye began to suppurate and panophthalmitis ensued. Inflammation was so violent that I did not even enucleate the eyeball, but allowed it to suppurate. I may remark here that authorities differ as to the expediency of enucleation under such circumstances. The idea seems to be that a suppurating eyeball never causes sympathetic inflammation. I, however, would not trust to the immunity arising from that condition, for I have seen sad exceptions to the rule, and such cases must be carefully watched.

PARALYSIS OF THE CILIARY MUSCLE

The ciliary muscle, as well as the sphincter iridis, being supplied by the third nerve, is liable to be implicated in paralysis of the motor oculi. When the other muscles, viz. the levator palpebræ, the recti, and the inferior oblique are involved, the diagnosis is plain, but when the short root of the nerve which goes to the ophthalmic ganglion is affected we have only paralysis of accommodation, sometimes with, but more frequently without, paralysis of the sphincter iridis. Indeed, we may say that the person has become presbyopic, only with this difference, that in presbyopia the pupil is contracted, whilst in paralysis it is, as a rule, rather dilated and immovable. The dilatation of the pupil may be either slight or very considerable.

The effect with regard to visual disturbance will, of course, be different in different states of refraction. Thus, in the case of old people the paralysis will be of little consequence, because presbyopes have already, to a great extent, parted with their accommodation. In the case of myopes, who have refraction to spare, whose punctum remotum is from twelve to fifteen inches from the eye, and who do not require to draw upon their accommodation for reading, close work can be done without inconvenience. The only disturbance they will be conscious of will be that objects situated at a greater distance will be more confused on account of the enlarged pupil, and the light will also be dazzling.

Emmetropes, on the other hand, will be more disturbed by loss of accommodative power. They will be able to see at a distance, but when trying to look at near objects they will notice a change which has taken place in their vision. When the pupil is also affected, the disturbance is greater, but the diagnosis is easier. When the sphincter iridis is involved, it is apt to be mistaken for amblyopia. When one eye only is affected, and this is generally the case, the patient soon begins to compare the sight of the one eye with that of the other, and finds out the deficiency.

But the greatest inconvenience will take place in the case of hypermetropes. They have distinct vision nowhere, not even at a distance, and must draw upon their accommodation. There will, therefore, be a circle of diffusion, even when looking at distant objects, and when trying to look at near objects the diffusion will be complete.

There is also sometimes *micropsia*, *i. e.* objects appear smaller, the same as in mydriasis by atropine. This is a characteristic symptom of paralysis of the ciliary muscle, when the pupil is dilated, because objects appear nearer than they are in reality, and inasmuch as the visual angle has not become greater, we imagine that the objects are smaller, for we judge of the distance of an object by the convergence of the visual axes, and the tension of accommodation, and the distance to which we project the image of an object in turn regulates our judgment as to its size.

The *cause* of paralysis of the ciliary muscle is generally ascribed to cold, rheumatism, syphilis, which causes periostitis and affects the sheath of the nerve.

The *treatment* must be regulated according to the cause of the affection. Thus, antirheumatics, such as colchicum, iod. potassium in large doses, and quinine are administered. When of syphilitic origin we prescribe a mercurial course. Arsenic, although temporary in its effect, is of great help. Suitable glasses must be given to relieve the optical disturbance.

If one eye only is affected, the patient gradually accustoms himself to the inconvenience, and lays the spectacles aside.

Prognosis.—It is generally cured, but you must bear in mind that it may be the precursor of cerebral affections.

Diphtheritic Paralysis or Paresis

In diphtheritis of the fauces (angina diphtheritica) the muscle of accommodation is also implicated. The pupil is not altered, but the affection is confined to the ciliary muscle. Both eyes are very rarely affected.

Tonics and good nourishment generally cure it within a few weeks. Eserine drops are also of considerable benefit. The muscle of accommodation may also sometimes share in the debility of the whole muscular system, after long protracted illness, or loss of blood, or through any debilitated condition. But this does not call for special treatment.

Spasm of Accommodation

Is an opposite affection. It is an excess of tone in the ciliary muscle, producing a condition analogous to that caused by the instillation of eserine. The pupil becomes smaller, the ciliary muscle is strained and painful, the lens more convex; in short, a state of painful myopia is induced. It may take place in emmetropic as well as in ametropic eyes. In hypermetropia spasm of accommodation is very natural, and is induced by perpetual strain. The hypermetrope, who constantly works his ciliary muscle even for the far point, gets it into a habitual state of contraction, and thus loses his power of relaxing it. Indeed, this is the mechanism by which latent hypermetropia is induced.

An emmetrope, again, may induce this state of things by overworking his eyes, by long protracted study, or doing fine work. But it can hardly be explained why myopes should ever be thus affected, as they do not strain the ciliary muscle at all, their refraction being sufficient for the punctum proximum. However, even myopes are not exempt from this affection, whereby they become myopic in a higher degree. It is a condition which does not assume a pathological significance, and can be easily overcome by keeping the pupil dilated by atropine for a considerable time, and by wearing suitable glasses.

The Vitreous Body

The vitreous is the largest of the dioptric media of the eye, and occupies about four fifths of the eyeball. It is quite transparent, and like thin jelly in its interior; its surface is covered by the hyaloid membrane. In front, the vitreous is hollowed out for the reception of the lens and its capsule and behind it is closely connected with the retina, which it supports.

The hyaloid is an extremely thin and clear membrane, which envelopes the vitreous. In front of the *ora serrata* the hyaloid proceeds, under the name of zonula of Zinn, to the border of the lens, where it coalesces with the lens capsule. During this course it divides into an anterior and posterior lamella, only the latter of which coalesces with the capsule of the lens somewhat behind its border, the anterior lamella forming the zonula or suspensory ligament of the lens, and the intermediate space being the "canal of Petit."

There are divergent opinions with regard to the composition of the vitreous, but the view of Hannover seems to be the one most generally adopted.

In examining the vitreous of men with the aid of chromic acid he found that a number of partitions run from the surface to the axis, so that on a transverse section of the eyeball, made from above downwards, numerous rays are seen to proceed from a central point, the whole structure resembling an orange. In mammalia, however, Hannover has seen concentric lamellæ, as in an onion.

Mr Bowman found the vitreous in the newly-born infant to present a peculiar fibrous structure, consisting of a dense network of fibres, with dark nuclear corpuscles at the points of interlacement, so that the structure bore a considerable resemblance to the enamel organ (*i. e.* to the gelatinous connective tissue of the embryonic dental sac).

Virchow's observations on the vitreous of the pig's embryo accord with Bowman's view. It is thought that the nourishment of the vitreous is drawn from the adjacent structures—viz., retina, choroid, and ciliary body.

More recently Schwalbe, Ivanoff, and Herzog Karl have shown that the vitreous is an organised body possessing a cellular element, the cells being generally more numerous in the region of the optic-nerve entrance, decreasing toward the equator, and again increasing in the neighbourhood of the *ora serrata*. The existence of these cells is necessary to explain the phenomena of inflammation of the vitreous body.

In 1879 Deutschmann published observations,[1] which tend to prove that the vitreous body secretes the fluid of the aqueous humour, for in withdrawing the aqueous humour from the dead body by means of a Pravaz's syringe he found that the aqueous chamber refills. I have tried the experiment along with Dr Foulis, first with horses' eyes cut out just after death, and upon freshly-killed bull's eyes, and we have then repeated the experiment of tapping the aqueous chamber in four cases in man, at periods varying from three to ten hours after death, and the result obtained is closely in accordance with Deutschmann's observations, viz. if we withdraw the aqueous humour, causing the cornea to be applied flatly upon the iris, in three hours' time the aqueous chamber is refilled, although not to the same extent, *e. g.* in withdrawing 17 cubic centimeters of fluid, the fluid is replaced to the extent of 13 cubic centimeters, but if we inject into the vitreous humour the same amount of a watery solution of Indian blue or carmine, the anterior chamber fills quickly, but never up to the amount withdrawn. We have carefully examined if the transudations were due to rupture of the zonula, but the parts were quite intact.

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[1] 'Archiv für Ophthalmologie,' xx, 3.

Should these be established by further experiments, we shall regard the vitreous, not only as an organised body, but also as a secreting organ.

SUPPURATION OF THE VITREOUS

After an injury, and especially when a foreign body is lodged within its substance, the vitreous body very rapidly takes on an inflammatory process, which soon enters upon a suppurative stage.

CASE.—James B—, aged 36, engineer, came, two hours after an accident, to the Ophthalmic Hospital, on the 8th February, 1881, with an injury to his left eye. In the course of his work a piece of steel had penetrated the centre of his cornea, traversed the lens, and lodged in the deep structures. The corneal wound was so fine that it could hardly be perceived, but the lens was completely opaque, with a mark upon the centre of the capsule, and the pupil was only slightly dilatable. Being anxious to watch the case for a few days, his eye was dressed and kept under observation. Two days after, he returned with violent inflammation of the injured eye, there being pus in the anterior chamber, and the uninjured eye appearing somewhat suspicious.

On enucleation of the injured eye I found this small foreign body lodged within the vitreous close to the posterior pole of the eye, weighing $\frac{1}{14}$th grain. Here, then, was a case of suppuration of the vitreous caused by the presence of a foreign body, and setting in, thirty-six hours after the accident. You may take this as a type of such cases.

But, instead of suppuration, the results of accidents, we have the common forms of disease of the vitreous, viz.:

1. Opacities. 2. Softening. 3. Detachment of the hyaloid from the vitreous.

Opacity of the vitreous occurs in a number of cases of choroiditis, sclero-choroiditis, and retino-choroiditis. The opacities are discovered with the ophthalmoscopic mirror alone, held at a distance of about six inches from the cornea, and appear in the form of fine points, which may be confined to the anterior thin layer, and do not impede vision or ophthalmoscopic examination. These may exist to such an imperceptible extent that, although they inconvenience the patient, we are unable to discover them. But when they extend to the whole of the vitreous, vision becomes impeded, and ophthalmoscopic examination impracticable, because they become like a dust-cloud in front of the fundus. They sometimes assume the form of filaments and shreds, which appear to the patient like bodies of various shapes.

Dense opacities of the vitreous, when setting in suddenly and obstructing vision to a considerable extent, are generally of hæmorrhagic origin, proceeding directly from the choroid.

Cause.—These opacities may either be caused by migration of cells of the vitreous itself, which become changed in structure and loosened, and float about with the movements of the eyeball, or by effusions from the choroid.

There is another class of opacities of rare occurrence in the form of fine white globules, sparkling like mercury. We have at present an interesting case of this variety under observation (March, 1881).

CASE.—James S—, aged 68, was for forty-five years engaged as an engraver to the Bank of England. In August last year he gave up work in consequence of dimness of vision. Pupils are both rigid, there is incipient cataract in both eyes, and, in addition, there are fine silvery globules moving rapidly to and fro in the vitreous .(more so in the right than in the left eye), central vision is perfect, and the patient can read Snellen 1½; but the sight is rather confused and the field contracted at the periphery. These crystals are principally composed of cholestrin, which may either be present alone or are mixed with brown pigment dust. They do not imply any great danger, for they may gradually disappear by absorption.

Muscæ volitantes (myodesopia, *μυια* a fly, εἶδος like) may be of physiological origin. These are simple entoptic images. If you look at the clear sky, or upon a white sheet of paper, through a pin-hole pierced in a card, you will see at the movement of the eye upwards some little globules, sometimes strung together like pearls, follow the movements upwards, and then gradually fall before the field of vision. They are physiological spectra and do not interfere with distinct vision. In cases of congestion of the head or derangement of the stomach, they may annoy the patient, but are of no pathological significance.

In connection with entoptic images or spectra, we may notice also the curious entoptic phenomenon of rendering the vessels of one's own retina visible. This result may be obtained by the method suggested by Listing, *i.e.*, by directing a pencil of light from a strong convex lens upon the outside of the sclerotic whilst the eye is turned inwards as far as possible. The eye should be directed to some dark medium, upon which will appear a design of the retinal vessels. The same result may be obtained by looking upon a dark back-ground, whilst the light of a wax-taper is made to pass rapidly before the eye. The retinal vessels, being situated in front of the rods and cones, are rendered visible by this method.

Softening of the Vitreous (Synchesis).

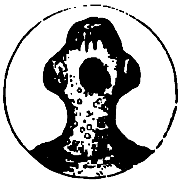
The vitreous may become simply softened and yet remain quite transparent, and this may be the result of a senile change, or may be induced by dilatation (ectasia) of the sclerotic. This condition is shown by the oscillation of the margin of the lens during the movements of the eye, and it requires careful attention when occurring in connection with senile cataract, for then special care must be taken during the extraction of the lens to prevent its sinking or prolapse of the vitreous. *Detachment* of the *vitreous* from the margin has been shown by Ivanoff and Herzog Karl to be of frequent occurrence, as the result of injuries or choroiditis, and is found also in myopic eyes with an elongated axis. It takes place by a process of gradual transudation, which may ultimately induce detachment of the retina.

Opacity of the vitreous may often be observed in young or middle-aged but otherwise healthy persons of the labouring classes, *e.g.* masons, outdoor labourers, and sewing girls, who consume large quantities of tea, which they carry with them to their work. Trousseau, whilst writing in his poetic style on the beneficial effects of coffee, states that tea, on the contrary, acts injuriously upon the digestive organs. This view is shared by other eminent physicians, and I shall not take it upon myself to decide whether that beverage, when used to an inordinate extent, has a directly injurious influence upon the nutrition of the eyeball, or whether the disease is owing, in the cases just referred to, to an exclusion of animal and vegetable nutriment, or to the fact that these persons consume an inferior or adulterated article. I merely mention the fact, that a large class of persons suffering from opacity of the vitreous are generally of a sallow complexion, with bad teeth and weak stomachs, and on inquiry we find that they live "mostly upon tea."

Treatment.—In cases of opacities from effusions, the patient must give up any occupation which tends to produce congestion of the head and eyes. Purgatives and tonics should be recommended, and, as it is mostly caused by mal-nutrition, light and generous diet should be ordered, and immoderate tea-drinking prohibited.

Cysticercus may sometimes be found in the anterior chamber, from which it is easily removed; but it more frequently occurs in the vitreous, where it appears as a semi-transparent, bluish-white cyst, with its outstretched neck, head, and sucking apparatus.

Fig. 90.

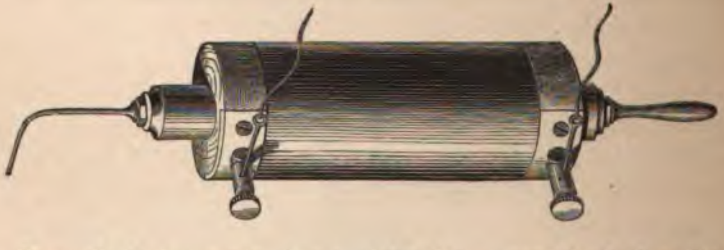


The head, however, may be drawn in, and remain invisible. It is sometimes situated between the retina and choroid, causing detachment of the membranes or condensation into one mass. Vision cannot be saved under these circumstances, and enucleation is the safest procedure. Entozoa, when occurring in the vitreous, always induce inflammatory changes in the retina.

FOREIGN BODIES IN THE VITREOUS HUMOUR

When a foreign body penetrates the sclerotic, and lodges in the vitreous humour, the eye is generally considered to be lost. When the body is small there is some chance of its becoming encysted without doing immediate harm; but there is only the choice of instantaneous enucleation or waiting the course of events. If, however, the body be large, the risk of sympathetic inflammation is so great that no alternative but immediate removal remains. Lately, however, Professor Hirschberg published an account of the extraction of foreign bodies from the vitreous by means of an instrument which he devised for the purpose.[1] It is represented in Fig. 91, connected with a galvanic apparatus. This is a valuable addition to our armoury, and has already been instrumental in saving some injured eyes from being sacrificed.

FIG. 91.



Several instruments have since been contrived for that purpose. Dr M'Hardie employs a battery by Hall, of Boston, and Mr Snell, of Sheffield, and Mr Owen, of Birmingham, use a large magnet connected with a thirty-cell Stöhrer's battery, which is charged with bichromate of potash. The thirty cells develop great power, the lever of the commutator is kept out of contact until the point touches the foreign body.

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[1] Dr McKeown, of Belfast, first suggested the removal of pieces of iron from the vitreous humour by means of a bar magnet. 'Br. Med. Journ.,' 1874.

The test for detecting the presence of a foreign body in the eye is touch. If, when the eyeball is gently touched in every direction, the patient starts as if pricked, you may assume with certainty that a foreign body is there; if he is passive you must not at once conclude that no foreign body is present, for it is possible that it may be too small or embedded in the lens substance, or in any other tissue, in such a manner as not to cause pain on pressure. You must, therefore, never neglect the application of that test, and consider it in connection with the size of the wound and other circumstances connected with the injury.

Diseases of the Choroid

When speaking of cyclitis I have already pointed out to you the close connection which exists between the inflammation of the iris, ciliary circle, and choroid, and that, as these diseases imperceptibly glide into each other their differentiation, in most cases, becomes impracticable. This fully accounts for the simplicity of nomenclature of old writers. The inflammation of the iris, ciliary body, choroid, retina, &c., was designated "*internal ophthalmia*;" this was divided into *anterior* and posterior, according to the hemisphere affected, and was called *general* when the whole of the internal membranes were involved; they correspond to the terms now in use—iritis, cyclitis, irido-choroiditis, choroiditis, and panophthalmitis.

There is a group of cases which may be brought under the classification of choroiditis, viz.

A. Suppuration of the choroid, which results generally from an injury, and especially from a foreign body lodging in it. When such a body enters through the cornea and lens there is set up at once, as a rule, so much mischief, involving all the internal parts, that choroiditis forms only a part of the general affection; but when it penetrates through the sclerotic at the equator there may be suppuration confined to the part, or a circumscribed abscess may be formed, shining through the cornea and vitreous, with a yellowish-white reflection from the fundus. We have such a case under observation at present (March, 1881).

When suppuration extends to the whole of the choroid, all the ocular tissues participate in the process, and we have destructive suppuration of the whole globe (*"panophthalmitis"*). It sets in with excessive throbbing pain in the eyeball, radiating in the direction of the inferior orbital and frontal nerves, with nocturnal exacerbations. The lids are swollen, red, hot, and very sensitive to pressure; the conjunctival sac is tumefied and dry, and is coloured by exuded blood; the cornea is opaque or suppurating; the eyeball is protruding and extremely sensitive to the touch, while complete blindness sets in at an early stage of the attack. We may call this the *sthenic* form of choroidal suppuration.

But the disease may run a milder course, with only slight throbbing pain and little œdema or protrusion of the eyeball. Here the purulent infiltration takes place inperceptibly, and I would call this the *asthenic* form.

Causes.—1. (*a*) Injuries, (*b*) foreign bodies lodged in the eyeball, (*c*) burns, (*d*) displaced lens, (*e*) unfortunate operations.

2. Virchow has shown that it is sometimes caused by thrombosis of the vessels in the inner part of the eye, or by embolism in puerperal diseases, where it is purely hæmorrhagic purulent inflammation, in which cases the retina becomes simultaneously affected, and pus collects between the choroid and retina.[1]

3. It sometimes occurs after variola, scarlet fever, or typhus fever, when it is developed by a metastatic process, or it may occur in connection with tuberculosis. It generally ends in shrinking of the globe, which cannot be saved, and therefore the only available treatment is paracentesis and soothing applications, hot poultices, &c.

4. As a result of chronic choroiditis, after contusion of the eyeball, there may occur a formation of bone between the choroid and vitreous. In 1865 I exhibited to the Academie de Chirurgie de Paris,[2] a curious specimen of bone formation at the fundus. Fig. 92 shows a still more interesting case. It is a bony cup filling the eyeball between the choroid and retina as far as the ciliary processes, having a perforation corresponding

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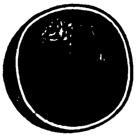
[1] 'Archiv für Pathol. Anatomie,' B. x, p. 181.

[2] 'Gazette des Hôpitaux,' August, 1865.

to the entrance of the optic nerve. It was taken from a patient, aged 55, who had his eye bruised thirty years previously, and who applied for relief in consequence of the commencement of sympathetic inflammation in the other eye.

FIG. 92.



B. *Serous choroiditis.*—This may occur in an acute form, when in consequence of the congestion of the vascular coat the retina and iris sympathize and become hyperæmic, and a few punctated spots make their appearance upon Descemet's membrane. This gives rise to retinal torpor, *i.e.* images are seen only in an intensely bright light. When the periphery is principally affected the visual field becomes contracted; but when the macula is implicated there is an impairment of central vision. Chronic choroiditis may, however, occur without any external sign of inflammation, and without leaving a trace in any tissue except the choroid, which undergoes some change, and exhibits pigmentous patches disseminated over the entire membrane, or over a portion of it. They are generally black, though sometimes white or light red. The black ones are due to hypertrophy of the choroidal pigment and epithelial cells, the pigment disappearing from the centre of these dark hillocks, leaving white spots surrounded by black margins. The bright red spots are probably caused by a loss of colour of the pigment epithelium, so that sometimes few choroidal vessels can be seen passing over the white back-ground of the sclera.

C. *Disseminated choroiditis* is that form in which the diseased portions are scattered and separated from one another. They are mostly congenital cases, which may, under favourable conditions, never progress, but whenever the eye is subjected to injury, however slight, or to iritis, it is apt to degenerate. Chromo., Plate IX, fig. 1, illustrates a case in which it was the result of intermarriage of first cousins. It is sometimes connected with softened vitreous and ectasia of the sclerotic.

D. *Syphilitic choroiditis* is represented in Chromo., Plate IX, fig. 2, which may be regarded as a type of that affection, viz. upon a normally-coloured fundus there are scattered numerous spots of various forms and colours. Some of them are whitish, others consist of black pigment, and others, again, look like delicate, ash-grey stripes. Exactly in the region of the macula there is a fresh hæmorrhagic spot. The disc and retinal vessels are also normal.

Treatment.—When active inflammation of the choroid is still going on, rest to the eye and protection from all glare by means of smoked or blue glasses is necessary. The diet should be regulated, and paracentesis of the aqueous chamber is very beneficial. Cases of congenital disseminated choroiditis do not call for any interference unless the affection assume an active inflammatory form.

E. *Detachment of the choroid.*—Although I have stated above that, in conformity with the anatomical structure of the choroid, inflammatory products are generally poured out on its inner surfaces, it very frequently occurs, as first shown by Ivanoff and Karl, in cases of irido-choroiditis, that the morbid material is exuded on the outside, causing detachment of the choroid from the sclera. The exudation may take place in the choroidal stroma without any apparent inflammatory symptoms, just as is the case in detachment of the retina.

Choroidal detachment presents, under the ophthalmoscope, a number of circumscribed prominences, upon whose surfaces the choroid as well as the retina can be seen, both membranes having been raised from the sclera.

F. Hæmorrhage into the tissue of the choroid is comparatively rare; but when it does occur it can easily be distinguished, as the retinal vessels may be seen running in front of the choroidal apoplectic patches. I have referred above to a case where we could see the hæmorrhagic patch behind a retinal detachment.

G. *Tubercle in the choroid.*—Manz and Cohnheim have demonstrated that tubercles occur almost constantly in connection with pulmonary and intestinal miliary tuberculosis.

They are situated most frequently in the neighbourhood of the optic disc, but sometimes also in the periphery of the choroid. When small they cannot be discovered by the ophthalmoscope, but when they reach the size of 1 mm., the pigment is lighter, and the nodules shining through the retina assume the appearance of rose-tinted protuberances above the fundus. The tubercles may be accompanied with inflammatory changes in the neighbouring parts of the retina.

H. Coloboma of the choroid generally occurs in connection with coloboma iridis. I have seen cases of coloboma, however, situated at the posterior hemisphere with normal irides, and, on the other hand, I have met with cases of coloboma iridis without abnormality in the vascular tunic. Central vision is not affected, but there is always a defect in peripheric vision, there being a scotoma corresponding to the deficient portion of the choroid.

LECTURE XVIII

ON GLAUCOMA

GENTLEMEN,—The disease called glaucoma (γλαυκος, green) from the peculiar sea-green appearance of the pupil, is one o the most dangerous and insidious affections of the eye. Th study of it has of late years become particularly interestin from the fact that it has been removed from the category o incurable diseases, and in many cases rendered remediabl by the timely operation of iridectomy; and for this practic we are indebted to the genius of von Graefe. The disease i characterised by the hardness of the eyeball; excavation o the optic nerve, rendering it cup-shaped or pitcher-shaped hyperæmia and inflammation of the deep structures; spontaneous arterial and venous pulsation of the optic nerve; an disturbance of vision, ranging from mere dimness to complete abolition of sight. The inflammatory symptoms ma be entirely absent, and the other symptoms may exist only to a slight extent; but the characteristic symptom which i never absent, is hardness of the eyeball, and this is due t an abnormal increase of intra-ocular pressure. As this increase of pressure may exist without an inflammatory process, we must conclude that it cannot be the product of inflammation. The disease may be divided into—

I. Inflammatory glaucoma ("glaucoma c. ophthalmia" o Donders), comprising those cases in which an inflammatory process is present, which may be either (*a*) acute or (*b*) chronic.

II. Glaucoma simplex, comprising those cases in which there is only increased tension without apparent inflammation.

I. (*a*) ACUTE INFLAMMATORY GLAUCOMA

forms the majority of cases. It sets in with ciliary neuralgia, in which there is pain in the eyeball, the brow, and the temple, and which sometimes extends to the entire half of the head, and is reflected to the stomach, producing vomiting. The patient complains of dimness of vision and of a halo surrounding any flames, the outer margin of the halo being red, the inner margin bluish green, and between these the ordinary prismatic colours. He sees sparks of various colours before his eye, which may be owing to the dilatation of the pupil, to change in the lens, or more particularly, to disturbance of the circulation. You may be told, on inquiry, that he has been troubled for some time past with frequently recurring symptoms of neuralgic pain in the head on the affected side, and an occasional dimness of vision in trying to look at near objects; and as he is most likely of a gouty or rheumatic diathesis, the attention is apt to be diverted from the real nature of the disease, which is therefore regarded as a simple case of neuralgia.

Whenever such a case presents itself before you, examine the eye most carefully, and on putting your finger upon the eyeball and comparing it with the other eye (if that be still free from the disease) the affected eye will be found harder than the normal one, the pericorneal and episcleral regions hyperæmic, and the pupil slightly dilated and sluggish, which of itself is an untoward symptom, for in no other disease of the eye is the pupil in a condition of symptomatic mydriasis.

On ophthalmoscopic examination you will not discover any sign of disease in the choroid nor in the lens or vitreous, but the optic nerve will present an excavation—a peculiar cup-shaped appearance. The colour of the disc inclines at the beginning of the disease to blood red on account of the venous congestion, and is encircled by a yellowish-white arch or ring, which is characteristic. On the outermost border of the optic nerve entrance the vessels are bent by a lateral displacement at the point of exit, and spontaneous pulsation is seen at first in the veins only, but, when tension increases, also in the arteries, showing the disturbance in the circulation of the eye. This condition, which is the expression of a sudden increase of the intra-ocular pressure, may intermit—the tissues accommodating themselves to the tension for a short time; but the acute stage may progress, the ocular pressure continue, and when we next see the patient we may find the ciliary pain increased, the headache more excruciating, the eyeball harder, the arteries and veins of the pericorneal region highly distended, the episcleral tissues inflamed, the aqueous chamber narrower (the iris and lens being pressed forward as if the aqueous humour were exhausted), the iris immovable, and the pupil not effaced though widely dilated. The cloudiness of the dioptric media and the dilatation of the pupil produce the peculiar greenish colour of the fundus, formerly regarded as the pathognomonic symptom of the disease. The ciliary nerves in their passage to the anterior hemisphere of the globe being suddenly compressed, both sensation and conduction are interfered with, and the iris becomes more atrophied, and may be reduced to a small border, unless pre-existing iritis has caused adhesions of that membrane. The pressure upon the ciliary nerves causes some anæsthesia of the cornea, which becomes insensible to the touch; and von Graefe has shown that the sensibility of the cornea returns after the aqueous humour is drawn off by a paracentesis. The motor fibres of the ciliary nerves become paralysed, and the range of accommodation is limited. There is, as you may expect, disturbance of vision from cloudiness of the cornea and from paralysis of the optic nerve fibres both in the retina and in the lamina cribrosa, due to pressure. In this form of the disease vision is affected from the commencement, and may be reduced to mere perception of light in a few days, or even hours ("glaucoma fulminans" of Graefe); but in the largest number of cases it commences with indistinctness of vision, which gradually increases until a thick fog lies over the visual field. The limitation of the visual field begins at the inner side, and gradually advances to the middle, then the upper and lower peripheries become contracted and gradually narrowed from all sides, the fog thickens and envelopes objects, the field becomes obscured, and absolute darkness covers the field.

(b) Chronic Inflammatory Glaucoma

An acute attack of glaucoma, although most distressing to the patient, is the least dangerous form of the disease, because it is most amenable to treatment. The form most to be dreaded is chronic inflammatory glaucoma, in which the intra-ocular pressure creeps on slowly and insidiously, with only occasional slight neuralgic attacks. The increase of pressure is not sudden, but gradual, causing excavation of the disc and mischief to the retina and optic nerve, and inducing complete blindness without warning to the patient. Unfortunately we generally see these cases after the whole process has been gone through, and the eye is as hard as marble, so that we have not even an opportunity of examining the interior of the eye, because the cornea is hazy, the aqueous and vitreous humours cloudy, and perhaps the nucleus of the lens opaque. In cases where we have a chance of making ophthalmoscopic examination, we find the excavation has progressed; the disc, which was red, has become greyish or green, and, later on, the floor of the excavation is spotted with a dirty yellowish-grey colour, while arterial pulsation is more marked.

II. Glaucoma Simplex

In this form of the affection the intra-ocular pressure comes on gradually, without any symptom of inflammation, which, indeed, is absent during the whole course of the disease. The increasing pressure creeps on imperceptibly, and the place of entrance of the optic nerve, being the weakest point, yields, so that at first the tension is not very strongly marked, although excavation has already taken place. The peculiarity of this form is that the pressure is at the expense of the posterior hemisphere, whilst the cornea, aqueous chamber, and lens are not affected; the iris is atrophied and the pupil dilated, but not to such an extent as in the inflammatory form. There is no chromatopsia; the disc is generally white, and is situated in a hollow, the walls of which are formed by the sclera, and the retinal vessels are forced against the walls of the excavation, sometimes to such an extent that the floor of the excavation is destitute of vessels. The depth of the excavation may be calculated from the optical differences of the correcting lens required to enable us to see distinctly the erect image, first in the plain of the retina, and then in the floor of the excavation. In the inverted image the difference in parallax produced by moving the convex lens is directly dependent upon the difference of level; the greater the parallax the deeper the excavation. The margin of the excavation is often surrounded by a narrow, characteristic bright ring, due to atrophy of the choroid surrounding the optic disc (Chromo., Pl. II, fig. 1); and this atrophied choroidal ring may be staphylomatous. This state of things may last for years without apparent progress, the only marked symptom being the progressive hardness and the gradual contraction of the visual field. In connection with the subject of excavation we must, however, bear in mind, as I have already pointed out, that in some cases there exists a natural physiological cup or hollow of the disc without disease, and it is therefore of importance to compare the two eyes, for physiological excavation is symmetrical, and does not extend over the whole disc, and there is no displacement of the vessels.

Causes.—As the disease rarely occurs before the age of fifty, it is now believed to be a senile change in the tissues, although it was formerly thought to be connected with an atheromatous condition of the blood-vessels, and was regarded as an expression of rheumatism or gout. There is no doubt that there is an inherent tendency or predisposition to the affection. When such a tendency exists the disease may be induced by a very slight injury, in which case it is called *secondary glaucoma.*

Von Graefe regarded glaucoma as a form of choroiditis or irido-choroiditis, with effusion, by endosmosis, into the vitreous and aqueous humours.

In a paper[1] I maintained that there is no trace of iritis in glaucoma, neither is there choroiditis, but that the affection is owing to perturbation of the ciliary nerve. This view had been advanced by Tavignot in 1846; and I further suggested[1] that the whole range of glaucomatous symptoms may be accounted for, and the *modus operandi* of iridectomy in effecting its cure explained, on that hypothesis. I took the disease to be the result of hyperæsthesia of the sympathetic, the vaso-motor nerve which presides over the process of circulation, and can produce changes in the local circulation of the organ, by which the amount of blood, and consequently the temperature, may be increased or diminished. This will account for dilatation of the pupil, and also for engorgement of the humours, which gives rise to dragging of the filaments of the trigeminus, and this in its turn produces anæsthesia of the cornea and vitiated nutrition of the organ, the tension rendering the phenomena more complex, and the *tout ensemble* invariably tending to blindness. About the same time there appeared a reference, in the 'Annales d'Oculistique,' to the opinion of Donders, that "we must seek the proximate cause of glaucoma in hyperæsthesia of the fifth nerve, which regulates the secretion of the ocular fluid;" this theory was based upon the fact that after division of the fifth nerve the tension of the eyeball decreased and became soft, and it received corroboration from the experiments of Grenhaggen and Hippel, who found that electric irritation of the root of the fifth nerve produced a remarkable increase in intra-ocular pressure. Dr Brailey's recent observations on the dilatation of the ciliary arteries, which he found in dissecting glaucomatous eyes, only tend to corroborate the theory of paralysis of the sympathetic being the cause of the tension.

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[1] 'The Lancet,' 1859.

According to recent investigations of Mr Priestley Smith, which are based upon those of Schwalbe and Leber, with regard to the filtration of the intra-ocular fluids, "glaucoma is caused, in all cases, by an obstruction to the escape of the intra-ocular fluid through its normal outlet, the angle of the anterior chamber.

The obstructive change varies somewhat in the several forms of glaucoma, primary and secondary. In the great majority of instances it consists in a compression of the periphery of the iris against the opposing surface of the cornea, which closes the angle of the anterior chamber, and cuts off the access to Schlemm's canal. It has been ascertained by experiment that this condition of obstruction may be brought about artificially by raising the pressure in the vitreous chamber very slightly above that in the aqueous chamber; and this observation affords the clue to the origin of primary glaucoma. In the healthy eye a stream of fluid is constantly passing from the vitreous chamber to the aqueous chamber through the suspensory ligament and the circumlental space—the space which separates the margin of the lens from the ciliary processes. With the advance of life the circumlental space diminishes in width, in consequence of the continuously increasing volume of the lens. Even in the senile eye, however, a space remains which ordinarily suffices for the passage of the intra-ocular fluid. But if this space be further encroached upon, either by the lens or by the ciliary processes, a serious obstruction is set up. Fluid can then no longer escape from the vitreous chamber as fast as it is secreted into it; the lens and its suspensory ligament are driven forwards by the increasing pressure from behind, and push the ciliary processes against the periphery of the iris; the periphery of the iris applies itself to the opposing surface of the cornea, the angle of the anterior chamber is closed thereby, and glaucoma is established. As the intra-ocular pressure rises, a passive hyperæmia is set up in the ciliary processes, and then swelling causes a still firmer compression of the periphery of the iris against the cornea. The glaucomatous condition thus becomes self-intensifying. The starting-point of primary glaucoma, then, is an undue proximity between the margin of the lens and the ciliary processes. These structures have been found in close contact in specimens of recent glaucoma; in the later stages they become separated by atrophy and distension. Primary glaucoma is confined almost exclusively to the second half of life, because the lens is considerably larger in the senile eye than in that of the young adult. A series of exact observations has proved that the average volume of the lens increases with each decade. When this predisposing condition is already present swelling of the ciliary processes may light up the disease; hence the connection of glaucomatous attacks with certain nervous and vascular disorders. Swelling of the entire lens, as the result of injury, induces a secondary glaucoma, in a manner very similar to the foregoing. Tumours of the choroid and retina, and sometimes extravasations of blood into the vitreous, cause a secondary glaucoma by creating an excess of pressure in the vitreous chamber, which leads to closure of the angle of the anterior chamber in the manner above described. In other forms of secondary glaucoma the initial obstructive change is situated in the pupil; in others in the anterior chamber itself. In the latter case the iris and lens are displaced backwards instead of forwards."

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[1] 'British Medical Journal,' 1864.

There is a great deal in these researches worthy of consideration. It appears to me, however, that in dealing with such complex phenomena we must not limit our investigations to the place of the disease, but direct our attention also to the nerves which animate the ocular tissues. In 1827 Pourfour du Petit first observed that the sympathetic in the neck proceeds to the eye. Majendie and Bernard have led us a step further in that direction, but there is a great deal left to be done yet towards the elucidation of the subject. It is not long since Charcot has shown that herpes is merely an expression of the disease of the corresponding spinal ganglia, and that Trousseau has taught us to regard the phenomena of exophthalmic goître as a manifestation of a pathological condition of the cervical ganglia of the sympathetic. I think, therefore, if we pursue our study of the cilio-spinal nerve, in connection with the trigeminus, our knowledge of the former being as yet only fragmentary, we may, perhaps, obtain clearer views with regard to the genesis of glaucoma. What renders the subject so complex is that the different nerves which are distributed in the ocular tissues not only have a separate action, but anastomose and form a network; this gives rise to complicated physiological action, which is rendered still more complex when some of the nerves are affected at the same time, as by intra-ocular pressure. One thing appears evident—that we cannot exclude the nervous element as a factor in the morbid phenomena under consideration.

But the main question which has still to be answered is, "What is the genesis of that disease?" We only know that grief, anxiety, or protracted night-watching, in old nervous persons, generally induces eye tension. Sometimes it may be brought on by a very slight injury to the eyeball, but apparently there must be an inherent tendency to the affection.

Treatment.—The introduction of the operation of iridectomy for the cure of glaucoma opened a new era in ophthalmic surgery, and although the theory upon which the operation was founded was not reconcilable with the phenomena of the disease, yet the results, as proved on a large scale, were hailed as evidence of a great conquest over a previously incurable affection. I believe that its undoubted efficacy is due to neurotomy, for Nélaton obtained satisfactory results in tic doloureux by removing a part of the diseased nerve—an operation which was suggested by Allan Burns.[1]

In removing a part of the iris we remove a portion of the diseased nerves; and this, I think, has a modifying influence by cutting through the vicious circle which keeps up the disease. Mr Hancock published some papers in the 'Lancet' in 1859 on the cure of glaucoma by the section of the ciliary muscle, and both he and Mr Power were practising this operation; and I have no doubt that the results must have been satisfactory on the principle just indicated, viz. a section of the ciliary nerves which are distributed in the muscle of accommodation. I have, however, never tried the operation myself, being averse to the surgery of that region, from anatomical considerations.

The suggestion which has been made, that the cystoid union of the scleral wound relieves the intra-ocular pressure, has been sufficiently answered by Hirschberg, that he never saw any cystoid union;[2] indeed, there should be no cystoid union if the operation is properly performed; and besides, a cicatrix, instead of becoming more pliable, is, on the contrary, harder than the natural tissues.

More recently the operation of *sclerotomy* has been introduced for the cure of this affection.

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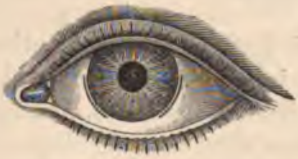
[1] 'Surgical Anatomy of the Head and Neck.'

[2] 'Centralblatt für praktische Augenheilkunde.

This operation is performed by introducing von Graefe's knife at the extreme periphery of the cornea at the sclerotic limbus, and pushing it in a horizontal direction to the opposite side, just as if it were intended to make a flap extraction; then, by two or three sawing motions, an opening is effected at the outer as well as the inner side of the scleral border, about a quarter of an inch in length. Fig. 93 shows the nature and extent of the section. You will see, therefore, from the very nature of the performance, that sclerotomy must be limited to those affections in which the pupil is contracted and rigid, and where there is no risk that the peripheric puncture will induce hernia iridis, as otherwise it is apt to complicate matters. De Wecker's opinion, that the operation is applicable to cases of *glaucoma simplex*, is a very safe one, for it may at least be said that if any one should try it in a case of inflammatory glaucoma he will be certain to produce traumatic cataract. His suggestion, however, that it must be aided by eserine and pilocarpine, somewhat detracts from its merits, for no operation can be worth much which requires the help of drugs. There is no doubt, however, that sclerotomy yields good results in some cases, for it gives free exit to the aqueous humour, and relieves tension to a considerable extent. I have practised it with success in some cases of secondary glaucomatous affection, where glaucomatous symptoms supervened on disease of the cornea, recurrent cyclitis, and keratoglobus; and in a case of the latter I found it reduced the globe, while it was beneficial in every case where, the cornea being opaque, an iridectomy might have had to be performed in the dark, as it were; but with regard to primary glaucoma, my confidence in iridectomy is too well founded to allow me to try any other treatment.

FIG. 93.



Dr. Argyll Robertson suggested to trephine the sclerotic, from which operation he obtained satisfactory results.

The operation of iridectomy is performed in the following manner:—Chloroform is administered only to nervous patients, and in cases where the eye is very painful. The patient being in a recumbent position, and the eyelids kept open by a speculum, the surgeon stands behind the patient; or if section is to be made downwards, he takes his position in front of the patient, who is ordered to look downwards; with the conjunctival forceps in the left hand, a part of the conjunctival and subconjunctival tissue is seized in order to steady the eye and with a curved lance (Fig. 94) in the right hand, the anterior chamber is entered through the conjunctiva, half a line from the corneo-scleral junction. The lance should then be held with its point looking to the cornea, for, owing to the shallowness of the aqueous chamber, the lens runs risk of being wounded. Then taking the curved iris forceps in the left hand, and the scissors in the right, the forceps are introduced, and the iris is seized at its pupillary margin and a segment of it withdrawn. Into this part a vertical incision is made from the pupillary margin to its ciliary attachment, a flap of iris thus remaining within the forceps, and, this being put upon the stretch, by means of two other cuts with the scissors, first in a horizontal and then in a vertical direction, the section is finished. Fig. 95 shows the appearance of the pupil after iridectomy performed downwards. By this method the exact portion of the iris can be measured which it is proposed to

FIG. 94.

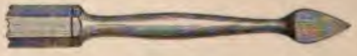
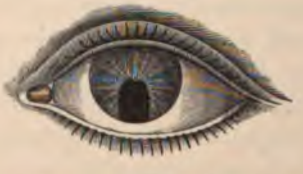


FIG. 95.



remove. When there is some blood in the aqueous chamber, slight pressure of the probe on the scleral lip of the wound is sufficient to cause its expulsion. An assistant is required for this operation to hold the speculum a little forwards, in order to prevent the pain caused by its pressure on the orbit. The forceps is dispensed with in the second stage, and the operation is thus performed with a minimum of pain, most of which is caused by the pressure of the speculum and fixation forceps. The dressing consists of lint secured by a bandage.

CASE 1. *Acute glaucoma; sudden invasion of symptoms caused by a slight injury and fright; double iridectomy; cure in one eye.*—Miss T—, aged seventy-nine, of a highly nervous temperament, enjoyed good health till May, 1878, never having suffered from gout or rheumatism, and not being subject to any eye affection, her sight being normal. About the time mentioned, the chimney of the room in which she was sitting caught fire, and in the midst of the confusion her hands and face were slightly singed. This accident frightened her exceedingly. The same night pain was experienced for some time in the top of the head, and this returned with greater severity on the succeeding night, depriving her of sleep. Two or three days later she appeared to herself to be enveloped in a cloud, as if the house were full of smoke, and this mist before her eyes gradually thickened until vision was almost abolished. She remained in this condition for five weeks, when I was called in by Dr. Christie to see her, and found both corneæ hazy-looking. The conjunctivæ were hyperæmic; tension T + 3, and vision almost *nil*; while focal illumination revealed the commencement of cataract in both eyes; opaque striæ advancing from the periphery of the lenses.

I performed iridectomy in both eyes on July 1st, 1878. The headache from which she had previously suffered was abated, the mist disappeared, and four days after the operation vision in the right eye was tolerably good, as she was subsequently able to walk about, and also to read ordinary type. The optic disc is represented in Fig. 96. In the left eye, however, excavation had advanced too far, the disc being found white and cupped, the vessels displaced from the floor of the excavation, and perception of light entirely abolished.

A London ophthalmic surgeon, a relative of the patient, saw her, and expressed the opinion that, if the iridectomy had been performed sooner, the sight of both eyes would have been saved; and of this there can be little doubt, for on January 6th, 1881, notwithstanding the advance of the cataract, and consequent limitation of the visual field, as represented in Fig. 97, she was able to read with ease No. 3½ Snellen's test-type with twelve inches convex glasses.

Fig. 96.

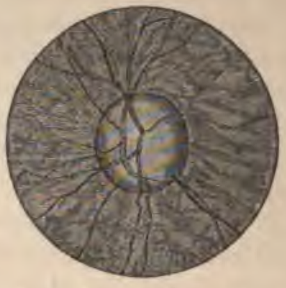
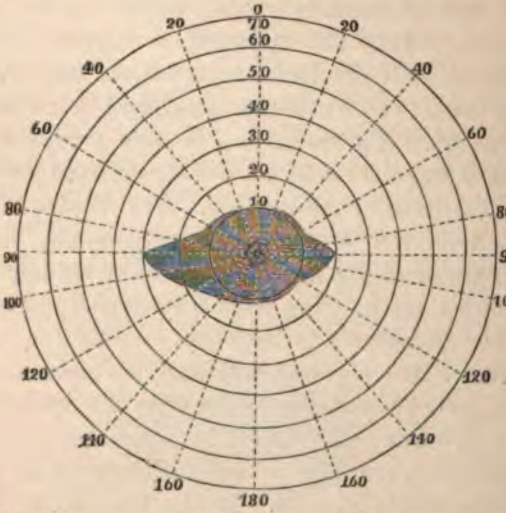


Fig. 97.



Case 2. *Glaucoma fulminans; iridectomy; cure.*—Mrs K— (from Dundee), aged about fifty, consulted me on May 14th, 1881. Sixteen years ago she began to suffer pain and

dimness of vision in the left eye, and Mr White Cooper pronounced it to be a case of glaucoma. Some years later an iridectomy had been performed upon it. She had never had any pain in it since, but the eye is cataractous and perception of light abolished. Some time ago she began to feel occasionally some uneasiness in the right eye, but on May 13th violent pain set in. She became "fog-bound," suffered excruciating pain on the right side of the head, attended with sickness during the night, and next morning vision was completely gone. In this condition she was brought to me. On examination I found the eyeball hard (T. 3), the cornea clear, the aqueous chamber shallow, iris forming a concavity forwards. Ophthalmoscopic examination showed the vitreous humour opaque, and the fundus invisible, as if masked by some dark body. As evening was approaching, I determined, for the sake of immediate relief, to perform a paracentesis, fearing lest by waiting another night every chance of saving vision would be lost. Immediately after she could see distinctly, went to bed, saying that she "was in paradise," and slept well. Two days after she could tell the time to a minute on a watch. The same night, however, pain returned, and I again resorted to paracentesis on the 17th. She then had other two quiet days with good sight; after which the symptoms began to reappear, although they were not so violent as before. I then performed an iridectomy on the 19th. Sight is good; she reads No. 2 Jaeger fluently with suitable glasses. According to the last report, two months after the operation, "vision is brilliant, and the eye feels more comfortable than it has done for some years past." The encouraging and hopeful feature of this case is the healthy appearance of the eye and the depth of the aqueous chamber, showing that a new condition has been induced. It is quite conceivable that the fencing with the disease by paracentesis has contributed to the ultimate success of the iridectomy.

In cases like these we may expect satisfactory results from iridectomy, but when the process of excavation has gone too far—when the sensitive part of the retina has been damaged, and the blood-vessels have assumed an atheromatous condition, it would be expecting too much from any operation to repair the lesion. The disappointments which followed unreasonable expectations with regard to iridectomy have led some surgeons to look out for another operative measure to cope with this disease. Now, as it is impossible to determine beforehand whether iridectomy is likely to be beneficial, I propose in every case of glaucoma to adopt paracentesis as a test. If the evacuation of the aqueous humour is followed by marked improvement, iridectomy may be performed with every prospect of a successful issue, otherwise no benefit can be expected from any operation.

LECTURE XIX

THE RETINA AND OPTIC NERVE

ANATOMY

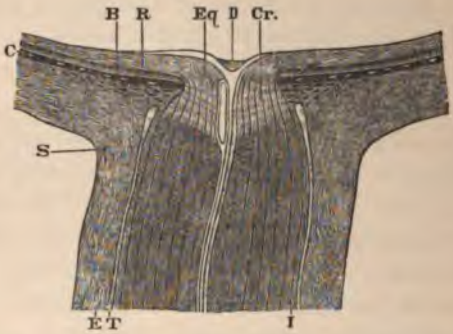
GENTLEMEN,—The optic nerve originates by an anterior root from the *thalamus opticus*, and a posterior from the *corpora quadrigemina*, and also receives filaments from the *corpora geniculata, substantia perforata antica, tuber cinereum*, and the *lamina terminalis*. A few bundles of filaments connect it directly with the posterior columns of the spinal cord and the grey cortical substance of the brain. Its trunk advances from the brain, as *tractus opticus*, along the posterior inferior surface of the *optic thalamus*, and, crossing the crura cerebri (without neurilemma, covered only by the delicate meninges), it runs forward at the side of the *tuber cinereum*, and, in front of the *infundibulum*, unites with the optic tract of the opposite side to form a chiasma.

This, with the two anterior parts of the striæ, bounds the floor of the third cerebral ventricle anteriorly and exteriorly. The optic nerves themselves proceed from its lateral portions; these, covered with neurilemma, run over the two segments of the *arteria corporis callosi* somewhat divergently in the two optic foramina; after passing these they become enveloped in a fibrous sheath, whose exterior is a continuation of the periosteum of the orbits. They then run somewhat tortuously, and enter the eyeball within and below the centre of the posterior half of the sclera.

In the chiasma a partial crossing of nerve-filaments occurs, for, from the inner side of each tract, a bundle of filaments passes to the optic nerve of the opposite side, and goes with this to the inner half of the retina. But the greater part of the filaments of each tract remain on the same side, and run through the outer part of the chiasma of the optic nerve, to spread out in the outer half of the retina.

The fibrous sheath of the orbital portion of the optic nerve may be divided into two firm connective-tissue layers, slightly mixed with elastic elements, an external thick (E, Fig. 98),

Fig. 98.[1]



and an inner thin one (I). Between the two is formed a thin layer (T) of loose connective tissue, containing a few fat cells, which continues anteriorly into the substance of the sclera (S).

The outer stratum of the fibrous sheath, however, goes on uninterruptedly and at an oblique angle into the posterior and middle layers of the posterior half of the sclera. The inner layer of the sheath, however, which represents the neurilemma, passes forward to the intraocular surface of the sclera, and there inclines, under a more acute angle, to the anterior layer of the sclera; so, at the optic foramen of the sclera, a more or less projected border, the connective-tissue ring, is formed, to which the edge of the posterior opening of the choroid (C) is attached by filamentary tissue. Posteriorly the scleral opening widens somewhat. It is entirely filled by the anterior part of the optic nerve.

From the inner surface of the neurilemma, in the whole course of the optic nerve, proceed a large number of firm tendinous processes, which envelope the individual bundles of the medulla, and in which the nutrient vessels and the nerves of the medulla branch out. Anteriorly and near the sclera these processes or internal nerve-sheaths become more abundant, and in the plane of the anterior scleral layer are strengthened by a thick network of elastic elements, which come from the thick tendinous sheath of the arteria centralis retinæ, and unite with analogous fibres from the sclera, and form the so-called *lamina cribrosa* (Cr.). This encloses the optic foramen of the sclera with a convexity directed somewhat backward, but affords the optic nerve-fibres and their sheath a passage. It often contains pigment-cells. Beyond the lamina cribrosa the bundles of optic-nerve filaments separate more from each other (cauda equina nervi optici, Eq.), but remain enveloped in connective-tissue sheaths, which here are transparent, even into the retina (R), whose bacillar stratum is here indicated by B.

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[1] From Stellwag.

In the interspaces are found large numbers of free nuclei or small cells, which in their entire bearing present some similarity to the cell formation found in the vitreous, and may be nearly related to the vitreous itself; for at the point in question the hyaloid as well as the limitans is entirely wanting; the vitreous lies immediately on the nest of cells traversed by soft connective tissue. The hyaloid is first developed at some distance from the centre, apparently by the union of connective-tissue filament. The nervous tubes lose their medulla, become, like the sheaths, transparent, yellowish or greyish, and take on altogether the character of the finest tubes in the brain; the head of the optic nerve then becomes to a certain extent transparent, so that in ophthalmoscopic examination the lamina cribrosa is seen.[1]

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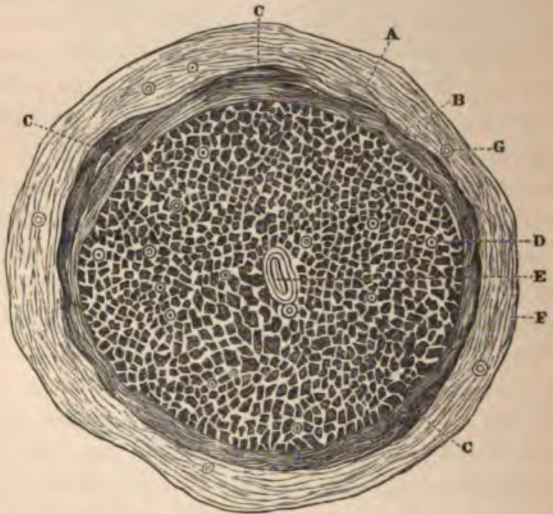
[1] This boundary between pellucid and cloudy tissue is not always, however, very distinct. Sometimes the optic nerve-tubes are accompanied into the retina by their sheaths, especially those on the periphery of the nerve-trunk. Sometimes, also, the inner nervous sheaths partially preserve their opacity, especially at the *peripheral* zone of the papilla. On the other hand, we find cases where the *central* parts of the papilla are absolutely more transparent than normally, or where the tubes, even before their passage through the lamina cribosa, have lost their sheath. Ophthalmoscopically, these anatomical variations present themselves as excavations of the optic papilla, and are described as *physiological* excavations. (E. Jaeger.)

The optic nerve-fibres, with their envelopes, are elevated perceptibly above the level of the inner scleral surface before they enter the retina, and so form a slight prominence, the optic disc or papilla (D). On the dead body, however, this often appears dish-shaped, or even funnel-shaped.

Fig. 99[1] represents a section of the optic nerve six millimeters from the disc, enlarged ten diameters.

FIG. 99.



A, external sheath; B, internal sheath; C, loose intervening cellular tissue; D, blood-vessels of the nerve; E, central vessels; F, the smallest nerve-fasciculi; G, blood-vessels of the external sheath.

The arteria centralis retinæ sometimes originates directly from the ophthalmic artery—sometimes is a twig of the ciliary or muscular branch. A few lines behind the sclera it pierces the sheath and medulla of the optic nerves obliquely, and then, enveloped in a thick adventitious membrane, from which filaments everywhere project into the neurilemma, it usually runs anteriorly into the disc without branching. In the latter it divides into two chief branches, of which one runs up, the other downwards; these again usually divide, either in the disc or near its border, so that four large branches enter the retina divergently.

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[1] From Ritter, in de Wecker's 'Maladies des Yeux.'

The retinal veins, like the arteries, unite to two superior and two inferior chief branches, which run in a convergent direction to the middle of the optic-nerve entrance. These four branches usually form two near or on the disc; these again unite at the point near the artery, or run apart as far as the lamina cribrosa, there to unite. The central vein and artery are never enclosed in the same sheath, and, as a rule, the former leaves the optic nerve quite near the posterior wall of the sclera.

Besides the chief branches of the central artery a variable number of small arterial and venous twigs are always found on the optic disc. These branch and anastomose variously with the vessels of the retina and choroid, and thus form a vascular connection between the ciliary and retinal blood-vessels, and, as Leber has demonstrated,[1] the retina does not receive its arterial vessels exclusively from the arteria centralis, but also by a circle of two or three small arteries from the posterior ciliary. These run into the sclerotic close to the optic nerve. This vascular circle had already been described by Haller and Zinn as contributing to the nourishment of the optic disc. It is by means of these vessels that the collateral circulation is established when the arteria centralis has been obstructed by an embolus. This has been proved by Kugel,[2] who, in experimenting upon a dog, tied the optic nerve near the sclerotic; the retinal vessels became at once empty, but after the lapse of twenty minutes the vessels became full again near the periphery, and after two hours they became of a normal calibre; then they became swollen, and gave rise to extravasation. The dissection which he made fifteen days later showed the existence of vascular arches stretching towards the ciliary body, which constituted an anastomosis between the vascular system of the retina and that of the choroid and iris.

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[1] 'Archiv für Oph.,' Bd, xi, A. i.

[2] 'Archiv für. Oph.,' Bd. ix.

DETACHMENT OF THE RETINA

Before entering upon the consideration of the various forms of retinitis, I shall call your attention to detachment of the retina and retinal hæmorrhage, two morbid conditions which cannot strictly be brought under the category of retinal inflammation.

When fluid is effused between the choroid and the retina the latter membrane becomes wrinkled, separated, and brought nearer the anterior hemisphere of the eye. This disease was known, even before the discovery of the ophthalmoscope, under the name of subretinal dropsy only, the existence of that condition could not be recognised unless the retina were much elevated and floated in front of the focus of the dioptric system, in the form of a bluish mass, so that it could be seen with the naked eye behind the crystalline lens, whilst by the aid of the ophthalmoscope we can discover it at its early stage, watch its progress, and determine those forms of the affection which come within the province of operative interference.

The subjective symptoms are, dimness of vision, then the interruption of the visual field, *i. e.* the patient sees when looking in one direction, but when looking in another a cloud seems to intervene between him and the object. Central vision is disturbed from the very commencement, on account of the intervening cloud, as the retinal fluid obstructs the passage of the rays of light. When the margin of the detachment approaches the macula objects appear slanted or crooked, and as soon as the macula loses perception of light there is eccentric fixation, a neighbouring portion of the retina being used for this purpose, and the axis deviates in that direction.

Ophthalmoscopic examination by the mirror alone, held at some distance, shows in the first stage a slight undulation of the retina. When further advanced a regular grey elevation becomes visible, which screens a part of the fundus when the eye is in motion. On examinination of the erect image the retinal vessels are seen crossing its surface. The grey opaque body gradually increases in size, and the subretinal fluid accumulates until no part of the fundus can be seen. This stage coincides with total loss of vision, when the detachment is said to be complete.

Retinal detachment occurs more frequently in one eye than in both. Bilateral detachment is generally considered to be the result of a high degree of myopia; but we have at present three cases under observation in old people with normal refraction. It may occur merely from serous infiltration, without appreciable inflammatory process or change of structure, or with change of structure in the retina, choroid, and vitreous (see Chromo, Plate VIII).

Retinal detachment may supervene idiopathically, or may be the result of an injury to the sclerotic or choroid. In idiopathic cases, even when the detachment begins in the upper portions, it generally gravitates downwards, and the originally detached portion of the retina again adheres and resumes its function.

In cases of injuries of the sclerotic at a given place, it is noteworthy, that the retina does not become detached at the portion corresponding to the site of the injury, but rather in a line opposite to it, as if by *contre-coup*, or at the lower segment. The detachment may be simple effusion without change of structure, or there may be changes in the retina itself, in the choroid, and the vitreous may be soft and opaque.

The *diagnosis* of the changes in the retina and vitreous has an important bearing on the question of operative interference for the removal of the dropsical effusion.

This affection had until very lately been classed among the incurable diseases to which the eye is subject. All medical treatment by the administration of mercury, leeching, &c., has proved worse than useless.

Von Graefe introduced an operation by puncturing the retina with a needle, and allowing the fluid to burst into the vitreous humour, and Mr Bowman performed the same operation with two needles. But I am not aware that this operation has ever been adopted by any surgeon. The reason is obvious, for when the detachment is partial one feels reluctant to thrust a needle into the retina with the chance of depriving the eye of the little sight it has left, and when the fluid has risen to the point of screening the whole fundus that operation offers hardly any chance of success.

Having observed in cases of laceration of the sclerotic how satisfactorily the wound heals without injury to the sight, if we secure coaptation, I have come to the conclusion that the safest operation for removing the fluid is to cut down upon the sclerotic, and evacuate the effused serum by puncture.

Operation.—The patient being put under chloroform and the speculum introduced, the assistant fixes the eyeball with forceps. A vertical slit is made with scissors into the conjunctiva and subconjunctival tissue, laying bare the sclerotic at a point corresponding to the site of the detachment, which is generally below the equator at its anterior aspect (Fig. 100.) The lips of the wound are separated by two small strabismus hooks, and the assistant steadily maintains the position of the eyeball to prevent the exposed portion of the sclerotic from shifting. The sclerotome (Fig. 101) is introduced into the sac formed by the fluid. The incision through the sclerotic is made obliquely in such a manner that the edges of the scleral wound should overlap each other when the instrument is withdrawn. Gentle pressure is made upon the eyeball in the track of the receding lance. To make sure that the whole fluid has been evacuated a little pressure with a fine silver spatula is made at the edge of the scleral wound. The lips of the external wound are brought together with a fine silk ligature or two, and both

FIG. 100.

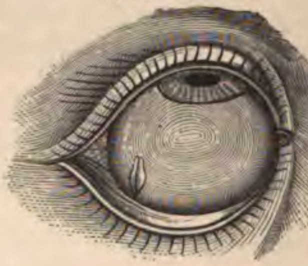
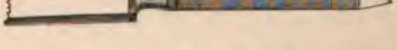


FIG. 101.



eyes are strapped with court plaster. The patient is kept in bed in a dark room for three days. The plaster and ligatures are removed on the sixth day, and the eye is gradually accustomed to the light. On the eighth day the result of the operation may be tested.

My first successful case was recorded[1] as follows:

Miss A. L—, æt. 58, who had previously enjoyed perfectly good health, felt her eyes beginning to get dim in October, 1877. When she consulted me in the January following, I found in the right eye retinal dropsy complete, and the left progressing in the same direction; and in May the detachment became complete in the left also. Vision was entirely abolished. Blindness was so complete that she could not follow the flame of a gas-burner passed within a few inches of her eyes. I operated on the right eye on the 15th September in the manner described above. On the eighth day I removed the bandage, with the view of testing her sight, which was highly satisfactory. Indeed there was no need to ask her the condition of her sight, for the cheerful expression of her face at once indicated the result obtained. She could distinguish persons distinctly and count fingers in all directions at two feet distance. The improvement progressed until twenty-two days after the operation, when she could see the time to a minute on a white-dialled watch, and distinguish between shades of colours, such as red and pink, green and blue. Six weeks after the operation she called herself at my house, having passed through a crowded thoroughfare unaided. The following year I received a letter addressed to me in her own handwriting. The remarkable feature was that the result was even more perfect in the left than in the right eye. This suggests the question—Did the effusion of this eye disappear spontaneously or in consequence of the fluid being withdrawn from the other?

After the publication of the above case, I became aware that Hirschberg operated successfully for detachment of the retina, and published some interesting papers on the subject.[2]

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[1] 'The Lancet,' Oct. 12th, 1878.

[2] 'Centralblatt.'

As my operation differs from his, I would indicate the points of difference. Hirschberg's operation consists of a puncture through the conjunctiva and fascia with Graefe's knife, and the fluid is allowed to well under the conjunctiva, and there to be absorbed. Professor Alfred Graefe adopted this operation, but Macnamara is the only surgeon in this country, to my knowledge, who followed this course.[1]

I think, however, von Graefe's knife unsuitable for this purpose. If you introduce any knife with one blunt edge into the tissue, the result is that the knife moves in the direction of the edge, and you obtain, not a limited puncture, but a larger incision than you contemplated, and a large incision in that region of the sclerotic is apt to produce ectasia and softening of the eyeball. And I have noticed that a large scleral wound in the anterior hemisphere is comparatively harmless, while behind the equator it tends to softening. Neither can I approve of a puncture under cover, as you are not quite sure what you have achieved. I always like to see what I am doing.

To what cases is the operation applicable? It would be useless to operate in a case of detachment when it is complicated with disease of the retina or choroid, or ectasia of the sclerotic with opaque vitreous. Neither can we expect any success when there is laceration of parts of the retina, so that shreds of it are floating within the detachment, and for this reason also, I think, *cæteris paribus*, a recent detachment more favourable than one of old standing, when the sentient elements of the retina have undergone changes of structure. But in cases of simple serous effusion, when the vitreous and choroid are healthy, there is a prospect of a successful issue. A glance at Chromo, Plate VIII, will show you at once that it would be useless to attempt an operation in such a case as is represented in fig. 1, though the detachment is less extensive, while, on the other hand, in such a case as in fig. 2, although the detachment is so extensive as to cover the whole of the optic disc, we may yet indulge the hope that the result of the operation will be satisfactory.

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[1] Hirschberg's cases may be considered the first publication on the subject. The case of Sichel in 'Clinique Européenne,' 1859, was merely puncturing the sclerotic for the relief of general dropsy, which infiltrated the eyeball in a case of cornea pellucida.

RETINAL HÆMORRHAGE—APOPLEXY OF THE RETINA

Retinal hæmorrhage is a frequent symptom of retinitis, and we shall have to consider it in connection with Bright's and other diseases. But we shall look at it here as an independent affection.

In a case of apoplexy of the retina, the exterior aspect of the eye is normal, there is neither pain nor uneasiness felt, and what induces the patient to seek advice is the deterioration of vision. On examining the eye with the ophthalmoscope, we find the apoplectic spots situated in the retina posteriorly to the equator, and consisting of extravasation either at a few points, or extending over the whole surface. Near the optic disc the spots are elongated and fan-shaped, because the nerve-fibres are thicker in this region, and the blood is radiating in the direction of the nerve-fibres. But near the equator, being situated in the middle layer of the retina, they appear circular spots or patches (see Chromo, Plate VII). Every hæmorrhagic spot causes an interruption in the visual field, but so long as they are situated in the periphery they are comparatively harmless. When they encroach upon the region of the macula, however, the sight is affected, and the patient says that a foreign body places itself before every object at which he is looking, the rays of light being absorbed by the effusion before reaching the rod-and-cone layer.

Cause.—Persons subject to hæmorrhagic retinitis are generally those suffering from some anomalies of the circulation, with heart affection or atheromatous condition of the arteries in an advanced stage or with arterial tension. Abdominal plethora and habitual congestion of the head may induce it. I have met some cases in women during pregnancy and in suppression of the menses.[1] The most remarkable case in my experience occurred this year (January, 1881) in a young medical practitioner.

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[1] Power "On the Diseases of the Eye occurring in connection with Pregnancy." 'The Lancet,' 1880, i, 709, 757.

Case of Dr O. H—, aged 25. The patient is of a strumous diathesis; had excellent sight till about six months ago, when he found that he saw double with both eyes, and when he shut his left eye the diplopia continued, showing an affection of the region of the macula. Objects were seen one above the other, the false image to the side and indistinct. At present the double vision is gone. The cause he assigns for this, which however I think to be a mistaken one, is that, whilst walking in bright sunshine, he was fascinated with this rare phenomenon in Glasgow and stared intently upon the sun, when he merely felt the glare, but no inconvenience. Next morning he had an attack of headache and bilious vomiting, which passed off. He had four similar attacks since, the last three weeks ago, of four days' duration, with frontal pain and violent pain at the back of the head. He rambled in his speech at night, and was slightly delirious. The present condition of the eyes are: in the left eye for distant objects vision $\frac{2}{3}$, and for near objects reads $1\frac{1}{2}$, Snellen's types perfectly distinct. Right eye, for distant objects, vision $\frac{1}{2}$, and for near objects reads $4\frac{1}{2}$ with ease, but cannot continue it for more than two minutes without the letters running together. He reads $3\frac{1}{2}$ with difficulty.

Ophthalmoscopic examination reveals a most suprising state of matters. If you look at the Chromo, Pl. VII, fig. 1, you will see an analogous condition. From this retinal apoplexy, extending over the region of the macula, and involving the optic discs, which are nearly obliterated, you would expect that vision would be very much reduced. I advised him to put himself under proper treatment, but when I next inquired for him, about the end of January, I learned that he had engaged himself as surgeon on board a steamship. I mention this case here to exemplify the general rule in connection with retinal hæmorrhage, and, indeed, with retinal diseases generally, viz. that ophthalmoscopic appearance does not always coincide with the extent of the retinal lesion. Thus, sometimes we are surprised to meet with a case of complete abolition of sight that the ophthalmoscope shows only a serous transudation, and, on the other hand, in cases where vision is very slightly affected, we notice extensive apoplectic patches with retinal sclerosis. The reason is that serious tissue changes may take place in parts which are inaccessible to our view, and, on the other hand, there may be apparent coarse changes in the retina, whilst the sensitive layers of that membrane are unaffected. It is, therefore, impossible to determine in any given case, the relation of the visual disturbance to ophthalmoscopic appearances, as they are not always in the same proportion.

Prognosis.—Small extravasations may disappear in a month or six weeks, when they begin to get pale at the borders, turning to orange, then to a whitish or greenish hue. But extensive hæmorrhages take almost a year or more to disappear. Sometimes, after it has disappeared, or when in process of disappearing at one place, a new extravasation takes place, assuming a chronic form, and then dragging on a tedious course.

It is a serious affection, not so much on account of the damage it does to the delicate structure as on account of the constitutional derangement, of which it is an accompaniment. It is more dangerous in the state of relapse.

The treatment must be directed to the disease of which it is symptomatic. Derivatives, mineral waters slightly purgative, and diuretics, may be ordered. With regard to local bleeding, de Wecker thinks that "it should not be resorted to without great caution, if we do not wish to augment the apoplectic patches, for congestion of the fundus always follows within several hours after all depletions practised in the neighbourhood of the eye."[1]

RETINITIS

In acute inflammation of the retina, the same as in apoplectic retinitis, there is no external symptom of disease. There is neither pain, redness, nor uneasiness felt; there is only dimness of vision, and the patient complains simply of a greyish-white cloud, which envelopes objects. Then he may also feel dazzling in full daylight, and, at a later stage of the disease, objects appear smaller (micropsia), distorted, slanting, or crooked.

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[1] 'Maladies des Yeux,' vol. ii, p. 328.

The ophthalmoscope reveals a grey opacity, which interferes with the transparency of the retina to such an extent that the subjacent choroid is hid from view. This may be the result of simple serous exudation or hypertrophy of the connective tissue. The opacity is particularly marked in the thickest part of the retina, *i. e.* in the neighbourhood of the optic disc. Hence, very often near the equator there is very little change in the fundus, but on approaching the disc you notice that its outline is obliterated. The disc itself is hyperæmic, for the numerous fine vessels, which in their normal condition give it a rosy tint when they become distended, cause an intense redness of the spot. The hyperæmia is most noticeable in the retinal veins, since the vessels are more distensible in a longitudinal than in a transverse direction; they become not only dilated, but also elongated, and thus appear thicker, tortuous, and larger than normal, and form arches into the opaque tissue of the retina. The deep vessels are vertical and hidden, so that they appear interrupted. The curves of the superficial vessels are sharply defined and intensely red. The arteries, on the other hand, are smaller than in their normal condition. This may be owing to the fact that the swelling and hyperæmia of the tissues extend into the intraocular end of the optic nerve, as far as the lamina cribrosa. If a swelling of the tissues occurs at this point, which is surrounded by the unyielding scleral ring, a compression of the central vessels may be caused, the immediate consequence of which will be both anæmia of the arteries and hyperæmia of the veins. We may call this *passive hyperæmia*, and you will notice the difference between it and active hyperæmia. When there is, for instance, inflammation of the eyeball by a foreign body lodged in the cornea, or in a case of choroiditis, or even in acute conjunctivitis, the retina, in sympathy with the vascular disturbance, becomes hyperæmic, the arteries as well as the veins become somewhat enlarged, and there is great sensibility to light—a totally different condition from the passive hyperæmia (stasis) we have just described.

Having thus given you an outline of the features which are common to all retinal inflammations, we shall now proceed to consider those symptoms which characterise the special forms of it.

RETINITIS ALBUMINURICA

Even before the discovery of the ophthalmoscope, Landouzy had directed attention to the co-existence of amaurosis in cases of Bright's disease,[1] and Türk[2] had found the retina studded with fatty molecules. Since the invention of the ophthalmoscope this subject has received great attention, and it has been established that its characteristic features, besides the ordinary signs of retinitis, viz. hyperæmia of the veins and clouding of the optic disc and surrounding retina, are the presence of a number of white, glistening granules in the fundus, interspersed with minute, sparsely scattered hæmorrhagic spots (Chromo, Pl. VII, fig. 2). When the white patches are united they form an irregular zone round the insertion of the optic nerve. Sometimes they have a stellated appearance, with the macula as a centre. They are the result of fatty degeneration, or sclerosis of the radiating fibres of the retina, which emerge towards the yellow spot. These white and red spots extend as far as the equator, whilst the peripheric portion of the retina remains normal. It has been further established that this form of retinitis is generally the result of albuminuric nephritis, which coincides with Bright's disease of the kidneys, but it is not exclusively so, for it may also be caused by other kidney diseases.[3] Vision varies in different subjects. It may be so good that ordinary print may still be read, or it may become so deteriorated that only fingers can be counted. Frerichs observed in forty-one cases fifteen with visual disturbance. Lebert states that in one fifth of his cases there were amblyopic symptoms.

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[1] 'Annales d'Oculistiques,' 1849 and 1851.

[2] "Anatomischer Befund des Amaurosis," 'Wiener Zeitschrift."

[3] We have at present (August, 1881) under treatment a case of white retinal patches, without disease of the kidneys.

Virchow and Müller have shown that this fatty degeneration commences in the granular layer and the ganglionic and nerve-fibrous layers, and that the chorio-capillaris may assume a state of sclerosis. Both choroid and vitreous participate in the disease; the pigmentary layer becomes either thickened or the pigment displaced, the vitreous becomes opaque by shreds from the choroidal pigment.

Retinitis in Bright's disease generally supervenes at a period when the renal structure has undergone a change and the urine has diminished in quantity, is of a lower specific gravity, and has lost a portion of its urea. A general disturbance of the circulation takes place and coincides with tension of the arterial system. This arterial tension is very likely the proximate cause of the retinal apoplexy and constitutional disturbances.[1]

When albuminuric retinitis has once set in it is sure to progress, and is rarely cured without leaving morbid traces behind.

Treatment.—The treatment must be directed to the constitutional affection, and attention must be paid to the state of the stomach and bowels to prevent constipation, and rest must be given to the eyes.

LEUCÆMIA

In retinitis, the result of leucæmia, the ophthalmoscopic appearance shows also opacity of the retina round the optic disc, with numerous hæmorrhages and small white spots. These spots, however, are not confined, as in Bright's disease, to the posterior hemisphere of the fundus, but may be seen both in the neighbourhood of the disc and in the peripheric portion of the retina. Lebert found, upon anatomical examination, that these white spots consist of accumulations of lymph-corpuscles. He therefore regards them as small leucæmic tumours, such as Virchow describes in various other organs, and Recklinghausen observed the bright spots in one case to be composed of thickened nerve-fibres. White lines are also sometimes seen along the course of the retinal vessels.

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[1] Moxon's "Croonian Lectures," 'Medical Times and Gazette,' May 14, 1881.

SYPHILITIC RETINITIS

This form is situated in the region of the macula, but as the choroid is generally affected both in its stroma and epithelium, it ought rather to be classed as chorio-retinitis described above.

NEURO-RETINITIS OR NEURITIS.

This is the name given to those cases in which the ophthalmoscopic changes are confined to the optic disc or its immediate neighbourhood. Here we are met with the very same appearances as in simple retinitis, viz. hyperæmia, cloudiness, and swelling. Hyperæmia is found in the veins which are distended, whilst the arteries are contracted. The disc is generally red, but is sometimes of a lilac or grey colour, which extends to the retina. The outline is hidden.

Generally the optic disc is more swollen and prominent than the retina, and you see the retinal vessels rising over the prominence and then sinking again to the level of the retina. The vessels, therefore, present a greater parallax than the neighbouring portions lying in the plane of the retina. In rare cases, however, the retina rises above and surrounds the optic disc like a wall. There are also hæmorrhages which are striated in the neighbourhood of the optic disc, and circular in the peripheral portion of the fundus. White spots may also make their appearance, either as the expression of fatty degeneration or of sclerosis.

The macula shows sometimes a peculiar stellate punctation. Visual disturbance is usually considerable, but the same remark is applicable, as in retinitis, that there is no correspondence between the opthalmoscopic appearance and the loss of vision. Loss of vision generally comes on gradually, but sometimes sudden blindness overtakes the patient in the course of a few days or even hours.

Cause.—In some cases no cause whatever can be assigned for the commencement of the disease, which appears to assume an independent form. In others it is caused by disturbance of the circulation in distant organs, viz. in irregular menstruation, syphilis, lead poisoning, growth of tumours in the orbit, meningitis, softening or tumours of the brain.

A very interesting case of neuro-retinitis, which is at present (May, 1881) under treatment is that of Mrs. D—, aged 29. She has enjoyed perfect health, but is rather spare looking. She was nursing her fifth child, four months old. On the 5th of April she had a shivering fit, accompanied by pain in the right side of the head, extending from the back to the temple, for which she was treated by fly blisters. Her sight was not diminished until three weeks later. When she came under treatment, blindness of the right eye was complete. Luminous perception was abolished. She was ordered to wean her child, and put upon a mercurial ointment and tonic course. After a fortnight's treatment vision began to return. She is at present in a fair way of recovery.

LECTURE XX

OPTIC NEURITIS—STAUUNGSPAPILLA (ENGORGED PAPILLA)

Gentlemen,—In 1853 Türk propounded the theory that an increase of intracranial pressure in some measure prevented the emptying of the ophthalmic veins into the cavernous sinus, and that thus disturbances of the circulation were caused, which extended to the optic nerve. In 1860 von Graefe explained, on the same principle, the characteristic swelling of the optic nerve in connection with brain tumours. This peculiar swelling he designated Stauungspapilla (see Chromo., Pl. V, figs. 1 and 2). It consists of an irregular swelling and redness of the optic nerve, an abnormal dilatation and curving of the veins, and a diminution of the contents of the arteries. If this condition is caused by brain disease both eyes are always affected.

It cannot be denied that Stauungspapilla depends on a stasis of the blood, but it is questioned if obstruction to the circulation within the cranial cavity plays any important part in this pathological process. Sesemann objects to the theory on anatomical grounds, because the vena centralis retinæ anastomoses freely with the vena ophthalmica superior, sometimes empties itself into it, and is therefore independent of the cavernous sinus. Further, he says that the compression of the cavernous sinus, by simple increase of intracranial pressure, is not so easy as one might think, and that, though in making injections he has often tried to compress the cavernous sinus, in order to prevent the escape of the mass through the zygmoid sinus, he has never succeeded. And he objects to it also on pathological grounds, because stasis takes place in the vena centralis retinæ alone, and not in the other branches of the ophthalmic vein, and, besides, that in some cases venous congestion of the retina is wanting when there is undoubted increase of intracranial pressure, and that, on the other hand, cerebral tumours may cause blindness without Stauungspapilla.

Schwalbe's investigations[1] have demonstrated that the space between the outer and inner nerve-sheaths is in direct communication with the arachnoidal space, so that an injection will pass from the one into the other, and hence inflammatory processes of the meninges of the brain may spread to the optic nerve, and produce the characteristic Stauungspapilla, for a persistence of this condition may give rise to œdema, and by this means cause a swelling of the optic disc, which may be of different degrees in its central and peripheral parts, or may vary in its different sectors. In the lamina cribrosa, where the optic nerve is surrounded by the sclera, the swelling of the nerve compresses its vessels, affecting principally the venous current. Schwalbe's theory, therefore, seems to be the more likely explanation of the course of the disease.

A very interesting case of double optic neuritis, caused by abscess of the brain, has been reported to me by my friend Dr Davidson, of Aberdeen. The patient, a ship carpenter, suffered from sunstroke in India for about two years. His sight diminished gradually, until at last he applied for relief at the Royal Infirmary, where he remained for two or three weeks. He suffered from double optic neuritis, more pronounced on the right side than on the left. A pulsation on the right side of the head having been discovered, and an abscess in that region suspected, the trephine was applied, and 8½ ounces of pus was drawn off. The man gradually recovered his health and sight, and when last heard of was engaged in Newcastle as a shipwright.

Stauungspapilla, however, may exist as an independent disease without cerebral affection.

ATROPHY OF THE OPTIC NERVE

In treating of neuro-retinitis we have shown you the image which that circumscribed inflammation exhibits at the ocular insertion of the optic nerve. Anatomical investigations have proved that the optic nerve can preserve its integrity, even after its intraocular expansion has suffered from frequent inflammatory attacks. But changes may take place in the nerve itself by a chronic inflammatory process. This manifests itself by a gradual disappearance of the nerve-fibres, which are partly replaced by cellular tissue of new formation. The disease sets in with dull, heavy, frontal, and occipital pain. The opthalmoscopic appearance shows haziness of the border of the optic disc; the vessels are thin, so as to be hardly traceable for any distance into the disc. There is anæsthesia of the retina; the visual field becomes limited, the limitation beginning usually at the inside, sometimes at the upper, and sometimes at the lower portions. Central vision is lost, nothing but the upper and external parts being left. The disease progresses until the whole retinal sensibility disappears. It generally commences in one eye, but soon extends to its fellow, which is very rarely spared. There is also loss of perception of colour.

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[1] Schultze's 'Archiv,' B. vi, 1870.

Treatment consists in counter-irritation with ammonia pomade[1] and iod. potassium internally. Deutschmann and Samelsohn[2] have reported favourably of the inhalation of amyl nitrite, and I consider the hypodermic injection of strychnine round the orbit in some cases highly beneficial. I have seen some remarkable cases of cure, which, however, may have been only a coincidence—a simple *post hoc*—but it certainly ought to be tried. More frequently, however, the disease pursues a different course. Instead of commencing with an inflammatory process it may be chronic in its nature, when we have

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[1] ℞ Axungiæ, ℥j;
Sevi Ovis, ʒij;
Liq. Ammoniæ Fort., ℥j.

Melt the lard and sheep's tallow, and when cooled to 95° Fahrenheit, add the ammoniæ. Shake to form a cream. Should crystals form, remelt and again shake. Put in glass stoppered bottle. Spread upon lint the size of florin pieces, and apply round the orbit.

[2] V. Graefe's 'Archiv," xxvii, and 'Centralblatt f. Pract. Augen Heilkunde,' July, 1881.

Progressive Atrophy of the Optic Nerve

This begins with contraction of the visual field, which may take place in both eyes at once, or very generally first in the one eye and then in the other. It may be at the interval of several years, but the affection is always symmetrical, *i. e.* in a corresponding part of the visual field in its inner or temporal periphery. The upper temporal part of the visual field is most frequently first attacked. Central vision also begins to fail early. The perception of colour becomes deficient, resulting in total blindness.

The first marked change which the disc presents is discolouration of the tissue. It loses its rosy hue, and is gradually transformed into a white surface (Chromo., Pl. III, fig. 1) by the obliteration of the capillaries. The nervous element of the disc loses its transparency, the scleral limit is very distinctly marked, the blood-vessels are diminished, and the optic disc becomes brighter. Sometimes it assumes a bluish or greenish-blue colour. In the centre of the disc its connective tissue is filled with bluish dots and lines, which are the bundle of nerve-fibres passing through it. The discolouration is always first apparent on the temporal half, while the inner half still retains its natural colour, because most of the nerve-fibres pass over this side, whilst on the temporal side the nerve-fibres are fewer, and hence atrophic changes will be sooner manifested there.

The atrophy may cause a flat impression, rendering only the lamina cribrosa visible.

Virchow describes it as an atrophy of the nerve-fibres and changes in the interfibrous substance, which either becomes œdematous or corpora amylacea, or nucleated cells develop in it. And he further distinguishes two kinds of grey atrophy, viz. a total and a partial or spotted. The spotted or grey atrophy of the opticus appears to be connected especially with the mottled atrophy of the spinal cord, and under these circumstances amaurosis is associated with paralysis and anæsthesia of the extremities, without affecting the brain. The atrophy of the opticus may end at the chiasma, or may exist behind, and may correspond with similar changes in the thalami optici and corpora quadrigemina.

The affection of the optic nerve in diseases of the spine is probably due to disease of the great sympathetic through its communication with the anterior roots of the spinal nerves. There are some cases of atrophy of the optic nerves in which no brain or spinal lesion can be discovered, and yet they may be followed by insanity, as shown by Lebert.[1] And Clifford Allbutt[2] has demonstrated that, in general paralysis of the insane, atrophy of the optic nerve is constantly found, and is commonly accompanied by atrophy of the olfactory nerves. It is not distinctly seen till the end of the first stage, as it slowly travels down from the optic centre, and it is in relation with the state of the pupil, which is contracted in the early period and dilated in the partly atrophic stage. In mania the ophthalmoscope often reveals symptomatic changes. In dementia organic disease and affection of the eye generally occur together. In idiots atrophy of the optic nerve is of frequent occurrence.

Anæsthesia of the retina is a very marked feature in progressive retinal atrophy. This is manifest in various ways, according to the change it produces in a single optic band upon the middle part of the commissure or upon a nervous cord in front of the commissure. As some fibres of the optic nerves cross in the chiasma, the external half of the retina of the corresponding side, as well as the internal half of the other retina, presents complete anæsthesia. This leads me to speak of the interesting phenomena of hemiopia.

HEMIOPIA.

The attention of the profession was first directed to this disease by Dr. Wollaston, who had himself had two attacks of it, each lasting from fifteen to twenty minutes, and with an interval of twenty years between them. On the one occasion the left, and on the other the right, side of the field of vision was obscured. Thus he mentions that, during the first attack, in looking at the name Johnson on a sign, he only saw —son, and during the second attack the left eye of a person he met was invisible to him. He had also observed the same affection in others, and published his observations on it.[1] After his death a large tumour, the size of a hen's egg, was found in his brain, and hence it appears that the existence of any cause of pressure on the brain may give rise to temporary and recurring disturbances of this nature.

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[1] "On Degeneration of the Optic Nerve," 'Archiv für Ophth.'

[2] On 'State of Optic Nerves and Retinæ, as seen in the Insane,' read before the Royal Medical and Chirurgical Society, February, 1868.

The name hemiopia (ἥμισυς, half; ὄψις, vision), then, is given to an affection by which, in both eyes half, or at least a corresponding part, of the field of vision is completely obliterated. This takes place whether the patient looks with one eye only or with both. The contraction of the field of vision may be on the same side of both eyes, viz. the right half of each may be wanting, and the line of demarcation between this and the normal part of the field quite sharply defined. This is called *homonymous hemiopia, i.e.* the corresponding halves, right or left, as the case may be, are affected. The abolition of the perception of colours is as clearly marked as that of the perception of light in general, and in this way hemiopia is distinguished from other defects of the field of vision.

When the inner parts of the two retinæ are affected and the external parts of the two fields of vision destroyed, it is called *temporal hemiopia.* It is, on the other hand, designated *nasal hemiopia,* when the external halves of the retinæ are impaired.

These obliterations of certain parts of the field of vision may be explained by the relations of the optic nerves to each other. At the chiasma there takes place a decussation of the optic nerve-fibres, as was first suggested by Sir Isaac Newton. One portion of the nerve-fibres of each optic tract is directed to the opposite side, crossing at the chiasma to go to the inner half of the corresponding retina. The other portion, without crossing, goes to the external half of the retina on its own side. If, therefore, by a tumour or hæmorrhage, there be compression of the right optic nerve on the central side of the chiasma, so that this nerve loses its conductibility, the right half of each retina will be impaired, and therefore the left half of each field of vision will be wanting.

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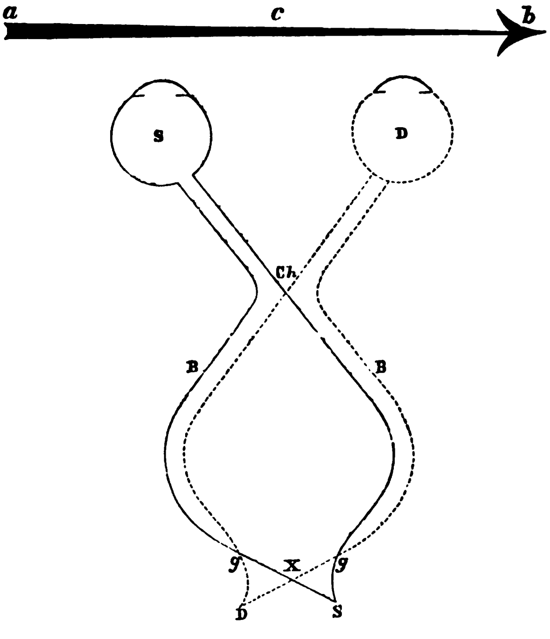
[1] 'Medical Gazette,' 1841.

But if the compression be limited to the commissure and affect only the crossed fibres, then the nasal side of each retina will suffer, and the temporal portions of the fields of vision be obliterated.

Fig. 101.



s is the left eye; D the right eye; *ch* the chiasma, where the optic nerve-fibres corresponding to the inner part of each retina cross; B B the optic tracts; *g g* the corpora geniculata; x the crossing of the fibres which do not cross in the chiasma; D the termination in the brain of all the optic nerve-fibres of the right eye; s the termination in the brain of all the optic nerve-fibres of the left eye.

To explain nasal hemiopia, it is maintained by Charcot that there must be a central encephalic focus, or a common centre for the termination of the optic nerve-fibres belonging to one eye, situated on the opposite side of the brain. The nerve-fibres, which do not cross at the chiasma, but form a part of the optic tract of the same side, must cross higher up, beyond the corpora geniculata, to come to the common centre of the nerve on that side, possibly in the neighbourhood of the corpora quadrigemina anteriora.

Now, according to this theory, any lesion at x (Fig. 101) will affect the external sides of the two retinæ, and therefore the inner parts of the fields of vision will be abolished. Each eye, therefore, in fixing the arrow *ab* will see only the part *cb*.

I must, however, remind you that anatomists and physiologists are not agreed as to the semi-decussation of the optic nerve-fibres. It is as yet merely a theory, and has not been sufficiently proved. The difficulty of investigating this subject in man is very great, on account of the complicated course of the fibres in the chiasma. Thus Mandelstamm, Michel, and Brown-Séquard[1] admit the total decussation of the optic nerve-fibres, and maintain that the phenomena of hemiopia can be equally explained by localising the affection at different parts of the chiasma. Gudden agrees with this view as regards the lower mammalia, but in man he maintains a semi-decussation. Cruveilhier[2] is also in favour of semi-decussation. At present the theory of semi-decussation seems to be generally adopted, having been recently confirmed by clinical observations of Hirschberg, Jackson, Landolt, Schweigger, Knapp, and others.

In temporal or nasal hemiopia there is not such a sharp line of demarcation as in homonymous hemiopia between the defective and normal portions of the field of vision, but rather a more or less broad line of transition, by which the one gradually passes into the other. The prognosis is also more favourable in the equilateral form of the disease, and absolute blindness is not to be feared until the cerebral disease on which it depends extends also to the other hemisphere. Hemiopia of the upper or lower halves of the field is very rarely met with, and the real nature of such cases cannot yet be explained.

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[1] "Recherches sur les communications de la Retine avec l'Encephale," 'Archiv de phys. norm. et Path.,' pp. 261, 262.

[2] Traité d'anatomie pathol. gen.,' t. iii, p. 146.

Cause.—Homonymous hemiopia is most frequently due to cerebral hæmorrhage, and then hemiplegia on the same side exists along with it. It often appears to depend on syphilis, and may also be caused by tubercle in the chiasma. When one half of the visual field is obscured, it may be due to an affection of the optic tract, while disease in the substance of the brain probably gives rise to those cases in which only a smaller corresponding part on both sides is affected.

PIGMENTATION OF THE RETINA—RETINITIS PIGMENTOSA

The first account of this disease was given by Ammon; then Trigot and v. Graefe demonstrated it ophthalmoscopically; and Donders, by his special researches, introduced it as a separate eye affection among the retinal diseases. Müller, Younge, Schweigger, and, lately, Bolling Pope, have contributed to the elucidation of the subject. The peculiarity of this form of retinitis is that it commences at the periphery and extends to the centre, thus taking the course opposite to that generally pursued by diseases of the fundus, without apparent change in the vascular part of the retina.

The symptoms are very characteristic. There is first hemeralopia. During daylight vision is sufficiently good, but when evening approaches, and at night, even large objects cannot be recognised. The patient becomes helpless, and cannot move about alone. This is caused by torpor of the retina, *i. e.* the retina reacts only under the stimulus of strong light, and very slightly, or not at all, under feeble illumination. When you take the patient into an artificially lighted room you can see, by changing the degree of illumination, that both central and peripheric vision is rapidly diminished in a faint light. This diminution of perception is out of proportion to the faintness of illumination. The torpor may progress until the retina is unimpressible by even the most powerful light. There is strong contraction of the pupil; the visual field becomes contracted; central vision is also affected, and ultimately blindness sets in. It may occur in emmetropic eyes, but more commonly in cases of strong myopia. Ophthalmoscopic examination reveals pigmentation of the retina, which begins at the periphery and extends to the macula.

The pigment is of a black colour, in the form of radiating specks resembling magnified bone-corpuscles. At first it is only to be seen in the periphery of the fundus, whence it spreads and surrounds the macula. The retinal vessels, especially the arteries, become thin. At a later stage the optic disc and the surrounding retina presents a light grey opacity. The vitreous shows membranous growths. The choroid may also be altered, when it becomes swollen, the rod-and-cone layer is destroyed, and the other nervous elements break down, and the choroidal pigment penetrates into the retinal substance, which is thus infiltrated with pigment cells by mere mechanical displacement.

There is a difference of opinion with regard to the question whether all the pigment in the retina comes from the choroid. The prevalent idea seems to be that it is also derived from the epithelium of the uvea. Pigment is also deposited along the vessels with intervening free spaces.

Donders, in a case which he long had under observation, found the retina adherent to the choroid at three or four places, where it was most pigmented, so that the two could not be separated. Lebert and Landolt report cases in which repeated previous ophthalmoscopic examination had revealed the typical appearances. The principal anatomical changes were an almost complete absence of the nervous elements, including the rods and cones, and hyperplasia of both the general connective tissue and that of the vessels, which accordingly were much thickened, had their calibre reduced, and their finest branches completely obliterated. In the walls were great quantities of pigment, which probably had partly migrated and partly been formed there, part contained in cells, and part free. The pigment of the epithelial layer had, for the most part, wandered away from it, and was collected at places in the retina in the typical manner, as determined by the course of the vessels.

The *cause* of the disease is congenital, and generally due to close intermarriages.

Dr Davidson, of Aberdeen, has furnished me with the record of two interesting cases of retinitis pigmentosa:

CASE 1.—Mr L— brought his girl, aged 10 years, for an eye affection. She is one of five children, the parents of whom are first cousins. From birth her sight has been weak, and she also suffers from nystagmus ($S = \frac{1}{2}$ in both eyes); tension is normal, the field of vision is concentrically contracted, and the characteristic pigmentous deposit in the retina is observable. Her sister, 8 years of age, is an idiot, Another is a deaf mute, and out of the whole family only one girl, 5 years of age, is well and in full possession of her senses.

CASE 2.—In June, 1881 a fine, robust young woman, 18 years of age, was brought to the Royal Infirmary for deficiency of sight. On testing her sight vision was equal to $\frac{1}{1}$, but she cannot see at night, and the mother thought some curious thing had happened in her family, as four other children were affected in the same way. Dr Davidson had examined these four children, aged 15, 17, 18, and 23 years respectively, the first and last males; those of 17 and 18 years of age females. In all, the same symptoms were observable, and the subjective symptoms were also very much alike, differing only in degree. The patient's father who is a farmer and understands the breeding of cattle, was annoyed to be told that close intermarriage was the cause of the defect.

On reviewing the literature of the subject I am inclined to the opinion that retinitis pigmentosa presents us with no new formation, but that the pigment is mostly derived from the choroid. The observations of Boll throw some light on the subject; for even physiologically these hexagonal pigment-cells behave very curiously. They seem to be migratory cells. When the eyes have been kept in a dark place, or in a red or yellow light, the retina can be easily separated from the pigment layer as a distinct membrane, and when the eyes are exposed to white, green, blue, or violet light, the pigment extends into the interstices of the retina, and the rod-and-cone layer cannot be separated from it. It is, therefore, not to be wondered at that, in a case of disease of the retina with a tendency to the breaking down and absorption of the nervous elements, such as Landolt observed, the epithelial layer becomes permanently adherent to the nervous tissue and the pigment scattered, presenting the characteristic forms just described.

I am further inclined to regard retinitis pigmentosa as merely an exaggerated form of disseminated choroiditis, with this difference, namely, that whilst the latter generally remains stationary for life, and the deposit is confined to the periphery, in the retinal form of the disease it spreads to the centre.

This view is the more reasonable when we consider the causation.

In both cases the cause seems to be too close intermarriage. In the case represented in Chromo. Plate IX, fig. 1, there was hemeralopia. Patient was the issue of first cousins. There is, further, colour blindness, which is due to the same cause, of which I shall treat more particularly in a subsequent lecture.

Amblyopia (ἀμβλυς, obtuse) and Amaurosis (ἄμαυρὸς, obscure)

Before the discovery of the ophthalmoscope, all diseases of the eye were divided into *cataract* and *amaurosis*. Among the former were included diseases of the lens and capsule, which were visible to the observer; and among the latter all diseases which lay beyond the power of examination by the surgeon. In differentiating cataract and amaurosis, it had been remarked that whilst in the former the physician saw something and the patient saw nothing, the latter was the condition in which neither party could see anything at all.

By the use of the ophthalmoscope, however, the true nature of most diseases of the inner ocular tunics and of the optic nerve has been revealed, and there is now no longer any good reason for classifying these under the head of amaurosis. The designation retro-bulbar neuritis, which is given to a condition in which sudden blindness occurs when the ophthalmoscope shows either no change at all or slight change disproportionate to the disturbance of vision, ought to enable us to blot out the term amaurosis from medical nomenclature. But the term amaurosis still lingers in ophthalmology, and is applied to cases of total or partial loss of sight, of which there is no material perceptible sign, and which, though the causes are not quite known, are probably due to intracranial or spinal disease.

In a case of this nature we cannot localize the disease from ophthalmoscopic appearances presented by the optic nerve. We must, therefore, look to the general symptoms for aid in arriving at a conclusion as to the cause and seat of the disease. And here I may remark that the study of the field of vision by the perimeter materially fills up the lacunæ left by the ophthalmoscope.

The definition of amblyopia and amaurosis is thus, for the most part, a negative one, simply because it is impossible to classify their various forms upon anatomical principles. The name *amblyopia* is given to those congenital forms of disturbance of vision, in which, with an eyeball perfectly formed, and an absence of all disease in the retina or optic nerve, there still exists an imperfection of vision. This may appear either in one eye alone or in both, not connected with anomalies of refraction. The visual field, as well as the condition of the fundus, is normal, and yet the person so affected cannot see further than to the distance of a few feet. It is generally associated with strabismus. Vision is, as a rule, stationary for life, without the slightest tendency to deterioration.

Another form of amblyopia consists in anæsthesia or diminished sensibility of the retina. This affection may either be connected with hysteria and other nervous affections, or may be reflected from disease of the other eye. Central vision is only very slightly diminished, but the visual field becomes contracted concentrically. The prognosis is generally favourable; recovery often occurs in the course of some weeks, but it may take years until vision and the visual field again become normal.

Treatment.—Von Graefe recommends that the patient be kept in a darkened room, and the light increased gradually.

He should also be made to wear dark blue or grey spectacles. For internal administration he recommends lactate of zinc ½ grain, increased gradually to 4 grains, daily. Rest to the eyes is also imperatively required.

Quite a large group of cases of amblyopia is characterised by diminution of vision, without limitation of the visual field, and without a trace of central scotoma. The fundus is perfectly normal, with sometimes only slight hyperæmia of the retina. Even after this form has existed for a long time the optic nerve may remain normal or may atrophy. The causes are generally to be found in constipation, coldness of the feet, suppression of habitual hæmorrhages or secretions, irregular sleep, undue straining of the eyes, excess in venery, immoderate smoking, or the abuse of spirituous liquors (*Amblyopia potatoria*). Treatment must be directed against the primary affection. The remedies are cathartics, iodide of potassium, mercury, or blue and quinine pills, and blistering with ammonia pomade.

The prognosis depends on whether the optic nerve has become pale. It is questionable if the removal of the cause will ever restore vision to its normal condition. I may also add to this class amblyopia caused by lead-poisoning.

Headaches attending amblyopia must not always be attributed to cerebral affections, for they may be produced by the endeavour of the patient to realize the visual impressions. When this is the cause, simple cessation from labour will cure it.

TOBACCO AMBLYOPIA

With regard to amblyopia, the result of the abuse of tobacco just alluded to, the opinion of medical authorities is divided. Since Mackenzie first directed public attention to tobacco amblyopia, its existence has been called into question in Germany and France, where everybody smokes, and there are comparatively few cases of nerve-disease resulting from it. Everybody in Turkey smokes incessantly, and it is remarkable how rarely optic-nerve diseases are to be met with in that country.

The quality of the tobacco may have a great deal to do with its injurious effects. There is no doubt, however, that smoking and the drinking of spirituous liquors has a great tendency to induce amblyopia.

The affection generally takes the form of partially white atrophy, with central scotoma. It progresses very slowly, and is associated with indigestion, constipation, disturbance of the nervous system, restless sleep, loss of memory, irregularity of the heart's action.

When the disease is in its first stage, abstinence from tobacco and drink is sufficient to produce a complete cure; but when central scotama does already exist, we can expect only a moderate result.

Amaurosis is sometimes due to intracranial causes. Generally both eyes are affected, but sometimes the disease is unilateral. The prognosis depends on the nature of the intracranial process. Sometimes some degree of vision may return, even after its total disappearance for several weeks or months.

There is another group of cases of cerebral amaurosis, in which absolute blindness invades suddenly, without any ophthalmoscopic symptoms being visible. It may disappear quickly or not at all. These are *uræmic amaurosis*, in which it is associated with other symptoms, viz. headache, sensation of heat, languor, shortness of breath, faintness or convulsions. It may also occur after typhoid or scarlet fever. Hughlings Jackson observed in many cases of epilepsy that absolute blindness preceded the loss of consciousness. This blindness is often so complete that there is not the slightest perception of light, but still vision may return within a few days. In other cases there may be only a partial improvement, or even none at all, and then begins an atrophic degeneration of the optic nerve. In these cases it is remarkable that, in spite of the loss of perception of light, the reaction of the pupil under its influence remains. V. Graefe explained this by the theory that the interruption of the central course of the optic nerve-fibres takes place at a point posterior to that at which it receives the branch of the oculo-motor, which supplies the iris. This fact is of great practical importance, for, so long as the reaction of the pupil is retained, the restoration of vision may be expected. But even when the pupillary reaction is lost, the possibility of the recovery of sight is not excluded.

The normal appearance of the disc during the first days of blindness is no guide to the diagnosis, for the atrophic changes do not set in for some weeks or months after the invasion.

Sudden blindness sometimes sets in after hæmorrhage from the stomach or bowels, and, as a rule in such cases, perception of light is lost after one or two days. I have seen one interesting case of a robust man, aged 37, brought to the Aberdeen Royal Infirmary, in which total blindness in both eyes set in immediately after an attack of violent vomiting and retching. There was nothing observable but slight hyperæmia of the optic nerve.

According to Hutchinson amaurosis may also occur in connection with carious teeth, even when the teeth are not painful.

Chronic meningitis at the base of the brain may produce blindness without any marked change of the optic nerve, but it manifests itself by febrile attacks, accompanied by violent headaches, severe vomiting and retching, and sensitiveness of the cranium to palpation. It may also be caused by chronic periostitis at the base of the brain.

Senile softening of the brain is not, as a rule, accompanied by amaurosis, but the disease may sometimes extend to the optic nerve. Epilepsy also, when symptomatic of brain affection, may produce amaurosis.

TUMOURS OF THE RETINA AND OPTIC NERVE

Carcinoma has never been observed as a primary disease of the optic nerve, and when it does occur it is only an extension from neighbouring parts. The three principal forms of tumours met with in the optic nerve are—(*a*) myoma, (*b*) glioma, (*c*) glio-sarcoma.

Treatment.—Speedy removal of the eyeball must be insisted on at the first manifestation of the disease. In 1875 a gentleman consulted me in the case of his child, 2 years of age, who had a small white, mother-of-pearl-coloured tumour, about the size of a pea, siuated at the fundus of the right eye. I recommended the removal of the eyeball without delay, but the parents were induced to take a more hopeful view of the case, which was then treated with grey powder, washes, &c. Three years later, however, they applied to Dr Robert Bell, who recommended them to lay aside all delicacy, and put the child under my care. By this time both eyeballs were enlarged to the size of hens' eggs, and protruding, ulcerating, and giving off a very offensive odour. The eyelids also were involved in the disease, and I had to remove the eyeballs and amputate eyelids, so as to give relief from the harassing pain and the intolerably offensive smell given off by the tumours. The child lived for about ten months after the operation in comparative comfort, and with a presentable appearance, but ultimately succumbed to the disease, which had broken out in some internal organ.

Under similar circumstances I have just now (September 9th, 1881), removed an eye from a girl, aged three years, recommended by Dr Gorman, of Rutherglen. Last year I advised the removal of the eyeball for incipient glioma retinæ. In consequence of the delay we had now to deal with a glio-sarcoma involving the whole eyeball and extending to the orbit.

Embolism of the Arteria Centralis Retinæ

The first case of sudden blindness caused by embolism of the arteria centralis was noticed by v. Graefe, and presented the following features :—On the first day of observation the refractive media were quite normal; the optic nerve was white, but not opaque, as in atrophy. All the vessels on the disc were greatly contracted; the principal arteries appeared like delicate lines, and their branches small; the veins thinner than normal, but larger near the equator.

A few days later a curious phenomenon was observed in the retinal veins. They appeared to be unequally filled, *i.e.* one portion was well filled, while the adjoining part was comparatively empty. On looking steadily at one particular part of a vessel it could be seen that the blood moved by rhythmic impulses towards the optic disc, now moving forwards, and then standing still.

Towards the end of the second week the retina, in the region of the macula, began to grow opaque; a greyish-white infiltration appeared, extending to the temporal margin of the optic disc, and shading off about the periphery into the healthy tissue in an imperceptible manner. The position of the fovea centralis was marked by a dark, cherry-red spot, about one fourth of the size of the optic disc. The colour of the spot was so intense as to suggest the presence of a hæmorrhage; still, it seemed more proper to regard the effect as due to a contrast in colour, for while the surrounding infiltrated retina by its opacity hid the choroid, that portion in the immediate neighbourhood of the fovea centralis remained free from infiltration, and allowed the choroid to shine through more distinctly. In the course of two or three weeks the infiltration disappeared, and with its disappearance the intense colour of the macula passed imperceptibly into a light-brown colour, not differing essentially from that of the neighbouring parts. There was only the faintest perception of light. Gradually atrophy of the optic nerve came on. Examination of the heart showed a stenosis of the aortic valves, probably in connection with a still active endocarditis. About a year later the patient succumbed to this heart disease; and post-mortem examination confirmed the diagnosis. Schweigger, who made the preparation of the eye, found that the arteria centralis, at the lamina cribrosa, was completely occluded by an embolus, which had forced its way up to this point. But in the lamina cribrosa the space was contracted, and there it remained fixed. On the cardiac side of the embolus the arteria was filled by a thrombus. Atrophy of the retina, above the optic disc, could be distinctly recognised. The lamina cribrosa was covered only by an atrophied tissue.

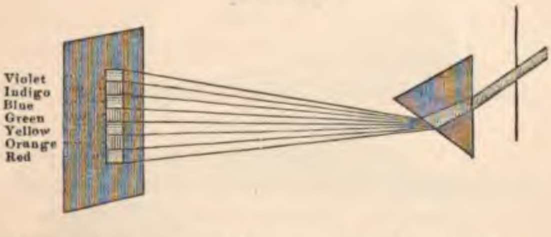
Since the first publication by v. Graefe a great many cases have been observed. A typical case is figured in Chromo, Plate X, fig. 2.

LECTURE XXI

COLOUR PERCEPTION AND COLOUR BLINDNESS

Gentlemen,—Newton demonstrated that white light, as, for example, that emitted by the sun, is composed of seven different kinds of light. If we admit a beam of sunlight through a small hole in the window-shutter of a dark room it will go in a straight line, and form a round white spot on the wall. If we now interpose a prism whose refracting angle is such that this beam of light may fall upon its first surface, and emerge at the same angle from its second surface, and if we receive the refracted beam upon a screen, instead of a white spot there will be formed upon the screen an oblong image of the sun, containing the seven colours (Fig. 102). This image is called the *solar* or *prismatic spectrum*, and the seven colours are called *primary colours*, because they cannot be decomposed, *i.e.* if a beam of light of one of these colours be passed through a prism it will merely be bent, the colour still remaining the same.

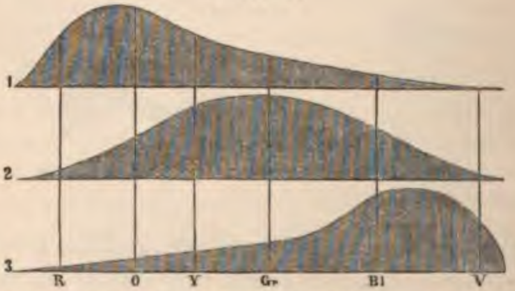
Fig. 102.



Adopting the undulatory theory of light (see p. 177) we find that red, which has the longest wave, is the least refrangible colour; whilst violet, which has the shortest wave, is the most refrangible; and green, which has a wave of medium length occupies the middle of the spectrum, or is of medium refrangibility.

Upon this simple view of the subject is founded the theory of perception of colour, first propounded by Thomas Young, lately defended by Helmholtz, and now generally adopted under the name of the Young-Helmholtz theory. The theory is that the retina has three distinct kinds of nervous elements or fibres, each of which perceives one of the three fundamental colours—red, green, and violet. The elements of the first class are excited in the highest degree by the red rays, but also slightly by the green, and feebly by the violet rays. Those in the second category are impressed by the green rays, and also feebly by the red and violet rays. The violet rays excite strongly the elements of the third category, which are little sensible to the green rays, and in a still less degree to the red. Every one of these elements, when excited, transmits to the brain the impression of its own fundamental colour. The impression of the intermediary colours is given by the excitation of two or three of these groups in different degrees, while when all the three are equally excited we receive the impression of white or grey colour. This diagram (Fig. 103) of Helmholtz explains his theory:

FIG. 103.



1, expresses the different degrees of excitation of red; 2, that of green; 3, that of violet. The vertical lines indicate the relation of the different coloured rays to the three nervous elements. The red, green, and violet rays (ought to) touch the highest points of the figures. The other lines also indicate the degree to which they excite the different retinal elements, by the extent to which they cut the different figures.

This theory, although the only explanation we are at present able to give of chromatic perception, is as yet merely a hypothesis. But, with the new point of departure in Boll's discovery of the erythropsine (see p. 7) we may be enabled to find a more simple explanation of the perception of colour. The little that we do know of the behaviour of erythropsine, under the influence of various coloured rays, is sufficient to show that it is an important factor in chromatic as well as in luminous perception.[1]

In the last letter which I received from the late Professor Boll he informed me that he had had several interesting conversations with Helmholtz on this subject. He said: "On the main point of the question Helmholtz agreed with me entirely, but some of his observations contributed very largely to correct my first views. I still continue to retain as certain the Young-Helmholtz theory, that every sensation of colour is composed of three different sensations. I admit in the retina the existence, not of three nerve-fibres, but of three different kinds of percipient organs, viz.—1st, the pigment cells; 2nd, the cones; 3rd, the rods. Every sensation of colour is threefold, being composed of three different irritations—the irritation of the pigment cells, the irritation of the cone, and the irritation of the rod. Helmholtz agrees with me that the proofs for this new theory are quite sufficient." He also read a memoir to the same effect before the Academia dei Lincei, entitled, "Tesi ed Ipotesi nelle Sensazione della Luce e dei Colori."

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[1] 1. In complete darkness, retinal red is like the middle of spectral red.

2. After long exposure to solar rays the retina becomes colourless.

3. In red light, retinal fundamental red becomes more saturated, like Pompeian or brownish red.

4. Yellow light does not much alter the fundamental colour of the retina, but renders it a little brighter.

5. Green light.

(*a*) The action of an intense green light, when of short duration (or of medium intensity prolonged), changes the fundamental colour into purple red, which getting paler turns into rose colour.

(*b*) When an intense green light is prolonged, the red purple passes off, becomes paler, and at last colourless.

6. Blue and violet.

(*a*) When of feeble intensity (or intense and of short duration) the colour changes into a muddy violet.

(*b*) When the intense rays are prolonged the violet is effaced, and the retina becomes quite colourless.

7. Ultra-violet rays have no physiological action upon the retina, however long they are continued.

Abnormal sensations of colour may be found in a state of disease, as in some forms of atrophy of the optic nerve, in hysterical epilepsy,[1] and in the case of habitual drunkards, &c., but every healthy retina is capable of receiving the impression of colour and its various shades, and of communicating that impression to the brain. The acuity of perception of different shades may be developed by practice, just as the ear may be trained in distinguishing musical notes. The physiological faculty is absent only in exceptional cases, which we must regard in the same light as harelip, cleft palate, deficiency of fingers and toes, or any other congenital abnormality.

Colour Blindness

Is a comparatively recent subject. The first cases of it were published by Joseph Huddart in the 'Philosophical Transactions,' London, 1777. But the subject excited little interest till the year 1794, when the celebrated English chemist, Dalton, who was colour blind, published an account of his own case, which attracted so much attention—it being considered a rare phenomenon—that subsequent writers called the defect Daltonism.

In 1805 Goethe published a treatise 'On the Pathology of

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[1] In view of the justifiable scepticism among the profession about the vagaries of hysteria, because they cannot be reconciled with physiological principles, I would merely mention here the demonstrations given by Prof. Charcot at the Hospital de la Salpêtrière in Paris. These demonstrations go to prove that hysteria in all its phases follows a course of mathematical regularity. The ease with which he makes hemianæsthesia and colour-blindness to oscillate from one side to the other is certainly very remarkable.

Colour Sight.' In 1837 Professor Seebeck was the first to examine a number of colour-blind persons, and to classify the degrees of their abnormal condition. But the most important work on the subject was that of Dr George Wilson, Professor of Chemistry in Edinburgh, which first appeared in the 'Monthly Journal of Medical Science' for November, 1853. "My own special attention," says Wilson, "was directed to the subject from the blunders which I found many chemical pupils make in reference to the colours of compounds. After making every allowance for imperfect exposition on my part, and insufficient attention on the part of my students, and after also making a large deduction for inaccurate answers on the score of imperfect remembrance and inability to name colours, I still found, in the laboratory and lecture room, that many a pupil was puzzled to describe the changes which occur when an acid or an alkali acts upon a vegetable colouring matter, although, to a normal eye, these changes are of the most marked character, and that in general I could count with little confidence upon accurate answers to questions regarding the colours of bodies."

A great deal has since been written on the subject, both in France and Germany. The most comprehensive and excellent treatise on colour blindness appeared recently by Prof. Holmgren, of Upsala, Sweden.[1] It is only just to the Edinburgh professor to say that some of Holmgren's striking points are due to Wilson's suggestions. Dr Joy Jeffries, of Boston, displayed great energy in directing public attention in America to this subject. Dr Stilling, of Cassel, and Dr Cohn, of Breslau, have also given us valuable contributions to the study of the subject; and my friend, Dr Hugo Magnus, has written several *brochures*, which have called forth high eulogiums from Mr Gladstone, who published a paper "On the Colour Sense of Homer" in the October number of the 'Nineteenth Century' in 1877. Mr Gladstone's paper has been mainly instrumental in directing public attention to the subject in this country. With the view of ascertaining to what extent the defect exists among the rising generation of this community, there was formed in Glasgow, in 1879, a commission, consisting of Dr Cumming, Dr Pickering, and myself, and, with the permission of the School Board, we visited several schools and examined upwards of 2000 childen. The results of our examination I shall state presently.

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[1] 'De la Cecité des Couleurs dans ses Rapports avec les Chemins de fer et la Marine.' Paris, 1878.

Colour blindness may be either—

1st. Total inability to discern colours (achromatopsy);

2nd. False vision of colours (chromato-pseudopsis); or

3rd. Difficult or blunted perception of colours (dyschromatopsy).

The first kind is very rare. Prof. Wilson records a case of a house painter, in whom the perception of black and white was all that existed to represent the colour sense. Magnus also has lately reported a similar case.

In the subjects of chromato-pseudopsis there is either an inability to discern a single colour, such as red, green, or violet, or there is an inability to discern the difference between two colours, such as red and green. Among the forms of the defect which are most frequently met with may be mentioned the following:

1. Blindness to green.
2. Blindness to green and deficiency in distinguishing red.
3. Blindness to both green and red.

Blindness to violet and its varieties is less frequent. In our examination we have only met with one case in which neither blue nor violet could be seen in the spectrum.

Cases of bluntness of perception, on the other hand, are of comparatively frequent occurrence. It is only right, therefore, that the public should be impressed with the fact that, including all varieties, colour blindness is of more common occurrence than is generally supposed. We were astonished indeed to find the number of cases which obtruded themselves, as it were, upon our notice.

Cause.—Some cases are caused by disease, but generally the defect is congenital, an inheritance transmitted from maternal relations. It is most probably due to the intermarriage of cousins or other near relations, and this is very likely the reason why Quakers furnish a large contingent of colour blind. Dr Wilson records six males in one family—uncles, nephews, and cousins—who were all markedly colour blind, and to whom the defect had descended from their maternal uncle. They all belonged to the Society of Friends. One of them, a minister of that body, bought for his wife a bottle-green dress, and for himself a coat of bright scarlet, instead of the conventional drab of the Society.

When colour blindness is caused by disease it may be cured, but when it is congenital it is incurable.

Seeing that the peculiarity of most colour-blind people is to mistake red for green, or to ignore a certain shade of red altogether, and to take green for yellow, the subject assumes a practical importance in connection with railway signals and lights in sailing vessels, steamers, and lighthouses. Red and green being of necessity the very colours used in railways, sailing vessels, and steamers, as well as in lighthouses, a colour-blind person may be the engine-driver of a train running a mile a minute, and thus the passengers' lives may depend upon his clear perception of the difference between a red and green light. He may mistake the danger signal, red, for grey or white, or when it appears black he may not see it at all, and he may take the green for the yellow or safety signal; or he may be the pilot on a steamer, and cannot say whether the light directly ahead of him is red or green, and hence cannot steer so as to avoid a collision.

It may well be asked, How is it possible for a colour-blind engine-driver, for instance, to perform his duty for any length of time without exposing his deficiency? But the explanation given by Holmgren is simple when we remember that a colour-blind person may come to distinguish between red, green, and white lanterns or flags, and even learn to call them by their right names, whilst all the time it is not colour which he sees; he only differentiates by the degree of intensity of light. The green is to him, as also to the normal eye, the deepest and darkest; the red is the most brilliant. As to the lanterns, the red blind always recognises the red light by its being darker than the green, and the yellow by its being clearer and more brilliant. The green blind distinguishes also the red, which he finds more brilliant than the green. In short, the colour-blind person supplements his defective vision of colour by all secondary aids. He trains himself to notice differences which escape most other eyes; these differences serve him in lieu of colour. That is the reason why collisions do not daily occur on railways and at sea from mistakes made by colour-blind officials.

Tests.—From the preceding remarks it will be evident that all examinations based on the naming of colours are no tests at all, for a person may be deficient in his colour vocabulary, and yet have an acute perception of colour, whilst another may have learned to attach the proper names to certain colours which he does not see, but of which he judges by the degree of luminosity. Hence also the reading of Snellen's coloured test types and Stilling's red types on green ground, &c., can prove nothing in regard to colour perception.

The test now generally considered the *experimentum crucis* is that originally proposed by Wilson, and elaborated by Holmgren. It consists in matching coloured skein worsted. You show a certain colour, which the person under examination is required to match. It is usual to begin with green and its shades, then go on to yellow, blue, and red.

Cohn and Jeffries regard it as a positive proof that a person's colour perception is normal when he can match coloured worsted put before him. Magnus, who, however, did not trust to this method alone, and added the spectroscope test to it, examined 5500 persons, regards his method as an absolute test, and recommends its general adoption throughout Germany.

Stilling also does not think the wool test quite reliable. I have come to the same conclusion after careful trial. I have found that in some undoubted cases of colour blindness the colours are easily matched. *To render this test of any value at all the colour should be matched when seen at a distance.* After having tested a large number in the usual way I had to abandon it, and resorted to examination in the following manner:—First, the person looked through the spectroscope, and was then asked to pick out from a heap of coloured worsteds the exact colours he saw in it; next, he was asked to match colours held up, one after another, at a distance of six feet from him. I have no hesitation in saying that this test is perfectly reliable. Goethe said: "You cannot reason for any length of time with an intelligent colour-blind man on colours without running the risk of getting crazy;" but the examination conducted in the manner just indicated is sometimes highly amusing.

The requirements previously mentioned for producing the spectrum not being always at our disposal, an instrument called the *spectroscope* has been devised for the purpose. It consists of the following parts:

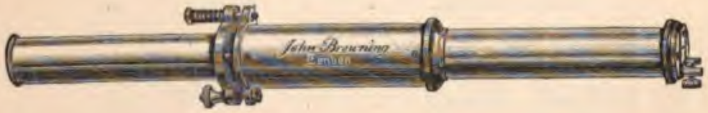
1. A telescope with a positive eyepiece on one end, and a slit regulated by a screw on the other, which is directed to the sun, or other source of the light we wish to examine.

2. A compound prism, consisting in all of five prisms, to give a considerable dispersive power, so as to separate the different colours of the spectrum as widely as possible.

3. A collimator, which is a contrivance to render rays from a slit parallel, by means of a lens placed at its own focal distance from the slit. The rays are thereby filtered, as it were, to prevent the mixture of rays of different colours.

Mr Browning, who makes spectroscopes of great precision, has constructed for me an instrument (Fig. 104) specially adapted for detecting colour blindness. It has a second slit, which moves in the focus of the positive eyepiece, and a slight movement of this adjusts the instrument for giving an isolated ray of any particular spectral colour.

FIG. 104.



STATISTICS

Total number examined	2134	
Colour blind	28, or 1·31	per cent.
Blunt of perception	143, or 6·70	,,
Examined with spectroscope, and at a distance of six feet from the colour to be matched	398	
Colour blind	12, or 3	,,

The subjects examined were all boys, for females are generally considered to be rarely deficient in colour perception. Whether it is really the case, or whether they are more apt to conceal the defect, is uncertain. We have, however, found in the case of one colour-blind boy that his sister is also colour blind.

COMPARATIVE STATISTICS[1]

Professor Wilson, of Edinburgh	5·6	per cent.
Dr Stilling, Cassel	5·0	,,
Professor Donders, Utrecht	6·6	,,
Dr Magnus, Breslau	3·27	,,
Dr Cohn, Breslau	3·6	,,
Professor Holmgren, Sweden	3·25	,,
Dr Jeffries, Boston	5·0	,,
Dr Freris, France	8·18	,,
Dr Favre, Lyons	9·33	,,
Glasgow Commission	3·0	,,

In conclusion, I would remark that it would be desirable to have hung up in schools diagrams of the spectral colours and scales of various shades, to accustom the eyes of the young to them, for just as the ear may be trained to the perception of musical sounds, so a great deal may be done in the way of educating the eye in the appreciation of the finer shades of colour, although colour blindness, when congenital, is incurable.

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[1] The difference in the results obtained by the various writers is easily explained, when we bear in mind that none of them take cognizance of dyschromatopsy. Some of them take bluntness of perception for colour blindness, while others disregard it altogether.

Peripheric Vision and the Visual Field

In the preceding lectures I have almost exclusively referred to vision as the result of images of objects formed on the macula lutea. Though it is the most sensitive part of the retina, vision is not entirely confined to this one spot, but extends more or less over the whole retina, which surrounds the macula for a considerable distance on all sides. In addition, therefore, to *direct* or *central* vision, we have *indirect* or *peripheric* vision. From what I have already said you will understand that peripheric vision is that in which the image is formed on some part of the retina lying outside of the macula, while the axis of the eye is kept directed to some fixed point, called the *point of fixation*. The whole space by which the eye can see while its axis is so kept fixed is called the *field of vision* or the *visual field*.

Notwithstanding its indistinctness and imperfection when compared with central vision, peripheric vision is of very great practical importance, for by it we can, while keeping the eye fixed on one object, see at the same time other objects around us, and without this much of the common work of daily life would be impossible, or at least rendered much more difficult for us. Without it we should, for example, be obliged, in walking, to keep our eyes fixed upon the ground, and should then be unable to perceive many obstacles which might lie in our way, or dangers which might threaten us on either hand.

In ophthalmic practice, too, the examination of the visual field, both as to its limits and functions, is of very great importance.

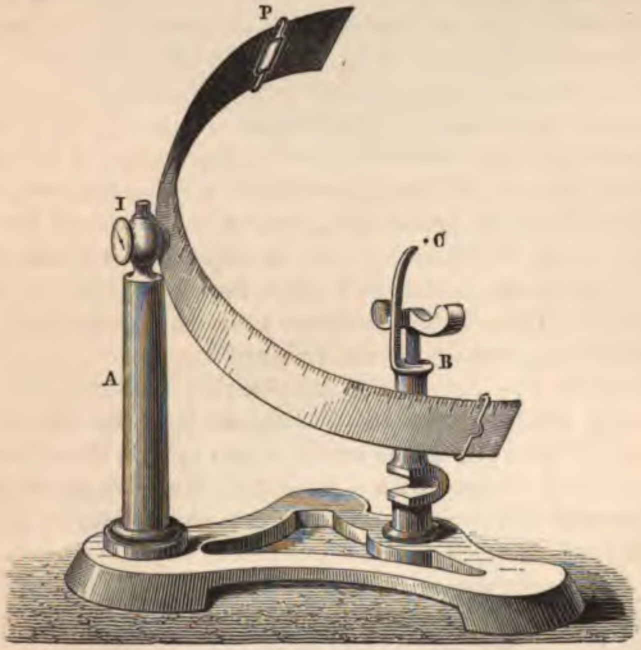
There are in common use two methods of fixing the limits of the visual field. The one generally recommended is, that the observer place his eye in the same horizontal plane with the eye to be examined, and make the patient direct his left eye upon the observer's right eye, or *vice versâ*, the other eye of each person being kept closed. The observer moves a suitable object midway between the two, and meanwhile watches that the patient keeps his eye steadily fixed on that opposite to it. He can thus fix the limits of the patient's field of vision, and at the same time compare it with his own.

For the second method of examination there is placed perpendicularly opposite the patient a board with a large sheet of blue paper attached, on which there is placed a distinct fixation-object at the centre. While one eye is kept closed and the other steadily looking at the object in the centre of the board, a piece of chalk or a white ball, fastened to the end of a long, thin, dark rod, is moved from the centre outwards, and the point marked at which the patient first fails to distinguish it. This is done in a number of directions from the centre, and then the points so obtained are united by a continuous curve, which is, in fact, the boundary of the field of vision.

It has, however, been proved that both of these methods fail in point of sufficiency and precision. If you keep one eye fixed on a finger of your left hand, and then move a finger of the right away from it in the arc of a horizontal circle, you will at once convince yourself that, with a normal eye, it is possible to distinguish movement through an angle of 90° or even more. Now, a line from the eye at an angle of 90° with the visual line will be parallel to a plane placed as described above, and therefore it is impossible to mark on such a plane a point corresponding to any object seen in this line. And not only is this plane insufficient for mapping the visual field, but also, so far as it goes even, it lacks in correctness, for on such a plane the further you remove the test-object from the centre the greater does the distance between the object and the retina become, and this, too, in constantly increasing proportion the further you advance. Up to an angle of 45° these differences may, for practical purposes, be neglected, but beyond this they become so great that any comparison between direct and indirect vision by such a method would be quite misleading.

It will be evident from what has been said that, to remedy these defects, a sphere must be substituted for a plane. We thus ensure that the object is always at the same distance from the retina, and can also extend our examination far beyond what is possible by means of a plane. On this principle Forster constructed the *perimeter*, an instrument by means of which alone the field of vision can be satisfactorily examined. It is to Förster that we are indebted for this valuable method of examination. Landolt has simplified this instrument, and Fig. 105 represents it as modified by him.[1] The most important part of it is a band, of the form of a semi-circumference of a circle, of a dull black colour inside, and fixed at its apex on a pivot, so that when turned round it describes a hemisphere.

FIG. 105.



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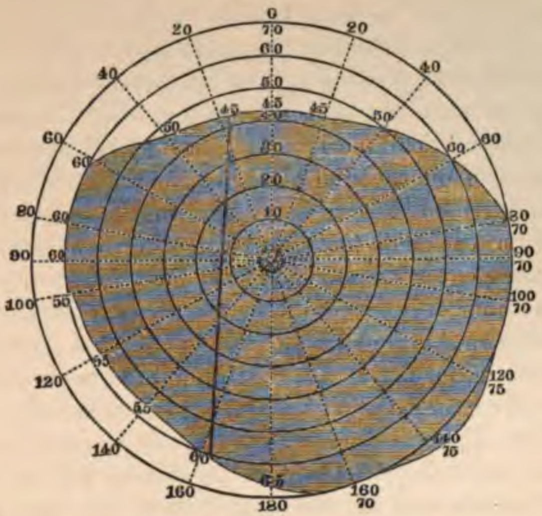
[1] The first ingenious instrument for field taking devised in this country was that of Dr Adams, of Maidstone; it has the form of a globe. Brudenell Carter has constructed a useful and portable instrument in the form of a quadrant.

From a common base rise two supports (A and B, Fig. 105). Near the top of it is the pivot, on one end of which is hung the arc (P), with a fixation object at its centre, and to the other end is attached a pointer, which travels round the small dial (I) as the arc (P) is turned round. The arc (P) is divided into degrees, numbered from 0° at the apex to 90° at either extremity. For about 20° on each side of the centre half degrees are marked, so that delicate measurements may be made in the neighbourhood of the macula. The dial is similarly divided, so that the inclination of P to vertical meridian can at once be read off upon it. The other support (B) at its upper end bends slightly backwards, and this part ought to reach to the lower edge of the orbit of the eye under examination. As part of the same support there is an adjustable rest, with a depression on each side for the chin. If the left eye is to be examined the chin must rest in the depression on the right side, and the rest is moved up or down till the extremity of B touches the lower orbital wall, so that the centre of the eye may be at C, the centre of the hemisphere described by P. The object (white or coloured paper, figure, or letter) is placed in a small frame, with a posterior arm, which points out the number of degrees on the outer side of the arc.

In using this instrument the observer first sees that the patient's head is properly placed, so that the eye to be examined is exactly in the centre of the sphere, the other eye having been covered with a bandage. He then places himself behind the perimeter, and directs the patient to fix the white spot in the centre of the arc, and watches that the eye does not move during examination. The arc having been placed in the meridian to be examined, the test-object is slowly advanced along the arc from the extremity towards the centre, until the eye under examination can clearly distinguish it. This point marks the limit of the visual field in this direction. The same thing is now done from the other extremity of the arc, and then, by changing the inclination of the arc, other points are similarly got for other meridians.

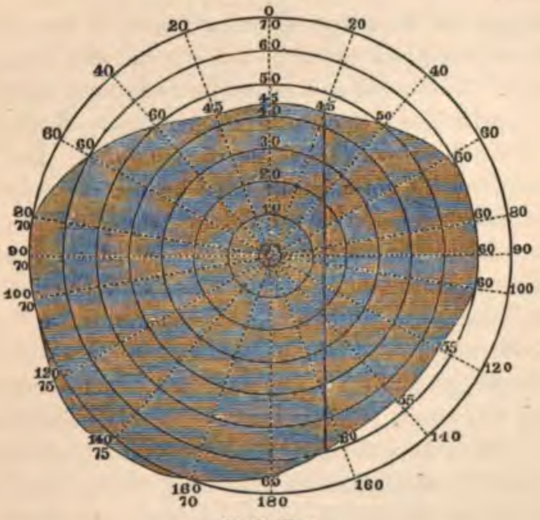
It is generally sufficient to examine four meridians, viz. the vertical and horizontal, and those midway between and inclined to them at an angle of 45°.

Fig. 106.



Right Eye.

Fig. 107.



Left Eye.

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[1] From Magnus' 'Ophthalmoscopischer Atlas.' The figures represent the normal field of vision, the average of a large number of persons examined by Förster.

In this way eight points are got, which can be laid down on a diagram, such as in Figs. 106 and 107. The centre of this diagram corresponds to the point of fixation, and round it are a number of concentric circles cut by several diameters, at the extremity of each of which is a number indicating its inclination to the vertical meridian. This number corresponds to the same one on the dial of the perimeter. The diameters, again, are divided at intervals of 5° from the centre (0°) to the extremity at each side (90°), and these divisions correspond to those on the outer side of the arc of the perimeter.

The number of degrees obtained by means of the perimeter for each meridian are then marked off on the corresponding diameters of the diagram, and, by joining these points by a continuous curve, we obtain an exact map of the field of vision, showing its limits in every direction. It is usual to place the diagrams for the right and left eyes side by side on the same sheet of paper—that for the right eye on the right, and that for the left on the left hand. These diagrams can easily be copied by means of tracing paper, and any number of them so obtained.

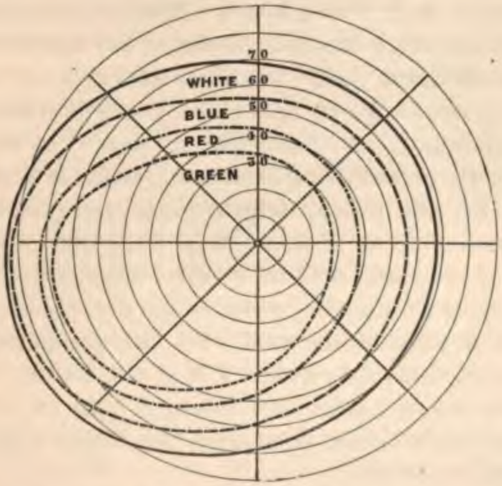
Such diagrams show that the visual field is not circular, as we might expect, but extends further on the temporal and lower sides. The nasal and upper portions are more limited, and this is principally due to the interposition of the superior edge of the orbit and the bridge of the nose. But Landolt has proved (and his conclusions have been confirmed by Donders) that this limitation of the field is partly due to the fact that the retina does not come so far forward on the outer as on the inner side of the globe, and also that the former part is less used than the latter. In indirect vision we look to the left side, for example, with the internal portion of the retina of the left eye, and not with the external part of that of the right, and *vice versâ*. The parts of the retina which are thus less used are, as a consequence, less perfectly developed, and thus we have a corresponding limitation of the visual field.

To determine the *perception of colours of the* same parts of the retina, we introduce into the frame of the perimeter variously-coloured papers, and move them along until the colours be recognised. The curves so obtained are quite different from the curves got when examining by ordinary white light.

The eye can recognise the movements of objects near the extremities of the perimeter long before it can distinguish their colours. Blue covers the largest field; in fact, its field extends nearly up to the limits of the general visual field. Red comes next as to the ease with which it can be distinguished, and appears first as black, then deep brown, brown, and finally red. The field of green is still more limited. It first appears as white or grey; then, nearer the centre, bright green appears yellow, and deep green greyish blue.

Fig. 108 shows you the curves which mark the limits of the visual field of these three colours. The space comprised within

FIG 108.



each curve indicates the colour of the test square which has been employed.

The periphery of the retina is not achromatopic, as has been supposed; for, by examination of the retina in a dark room, by isolating the colours of a solar spectrum, obtained in the ordinary way, and letting them fall on the periphery, Landolt has proved that all colours are recognised up to the limits of the field of vision, if they are of sufficient intensity and size, and have the proper contrast with the background or with the general illumination.

After having determined the limits of the visual field we next ascertain if there exist any defects or scotomata within the field, and mark their positions on the diagram. One of these defects, which I have already indicated, is physiological, viz. the one corresponding to the entrance of the optic nerve, known as *the blind spot*, or *Mariotte's spot* (p. 8). As the optic disc is on the inside of and a little above the macula, the corresponding defect in the visual field lies outwards from and slightly below the point of fixation. In the emmetropic eye it is generally 15° outward and 3° below, but Landolt and Dobrowolsky's experiments have proved that the interval is greater in hypermetropic and smaller in myopic eyes.

The examination of the visual field is of special importance in connection with internal eye affections, whether of the choroid, retina, or of the optic nerve as the result of cerebral and spinal diseases. For when an affection of the ocular system is symptomatic of such cases, you will always find the first indication in some irregularity of the field of vision.

a. Thus, in *choroiditis disseminata* there is usually some alteration of the retina, which gives rise to scotomata. Even at the beginning of this disease the perimeter shows the boundary of the visual field to be very irregular, or with scotomata scattered round the periphery. For this examination all colours of test-objects used with the perimeter will not serve the purpose equally well. The scotomata are much more clearly seen when a paper, for example, grey or red, is used which does not contrast so strongly as white with the dark background of the arc.

b. *In glaucoma* which I have already discussed, the examination of the visual field is very useful. For while we have other symptoms, especially tension of the eyeball, to guide us, still in glaucoma simplex, where excavation often takes place before there is any appreciable difference to the sense of touch, the perimeter comes to our assistance. At the commencement of this disease there is a marked diminution of the visual field, the limitation being principally in the inner and upper portions.

c. In detachment of the retina also, though we may imagine ourselves independent of any extraneous assistance, because the ophthalmoscope shows the detachment, yet the perimeter more clearly reveals the amount of mischief done. Vision being necessarily abolished in the part of the retina affected, there will be an exactly corresponding limitation of the visual field, so that the progress of this disease can be distinctly made out. A comparison of the results of perimetric and ophthalmoscopic examination will also aid us in our prognosis. Thus, for example, if the perimeter shows us a greater limitation of the visual field than the detachment shown by the opthalmoscope, we have in this a proof that still more of the retina has already lost its sensibility, and therefore we may expect an increase of the detachment. But if, on the other hand, a portion of the detached retina still retains its sensibility, we may indulge the hope that, by proper treatment, the retina may resume its place and function. The perimeter, therefore, aids us in our decision with regard to the expediency of operative interference.

d. Different forms of retinitis may be recognized by the different ways in which they limit and change the form of the visual field. Thus, in retinitis pigmentosa peripheric vision is first lost, while in retinitis symptomatic of syphilis and Bright's disease central vision first suffers.

e. The same means of examination will assist us in *diseases of* the *optic nerve,* posterior staphyloma, embolism of the arteria centralis retinæ, and hyperæmia or hæmorrhage at the macula.

f. We can also ascertain by means of the perimeter the existence of *hæmorrhages into the retinal tissue.* These hæmorrhages totally abolish vision in the parts of the retina covered by them, and therefore we have, in such cases, fixed scotomata in the visual field. By noting carefully at times the position and size of such a scotoma we can measure the progress of the disease, for so long as it continues active will the boundary of the scotoma enlarge and change.

g. One very important use of the perimeter is in the diagnosis of *diseases of the brain.* In retro-bulbar neuritis, for example, in which the ophthalmoscope leaves us entirely in the dark, the perimeter, even in cases in which the disease is followed by atrophy of the nerves, the perimeter comes to our aid. It indicates the presence of this affection by a concentric limitation of the visual field, and a diminution of visual acuity.

h. This instrument, again, helps to guide us to the special cause of *atrophy of the optic disc*, which may be the result of various nerve diseases. Central vision may be lost, but peripheric vision preserved, and then the prognosis depends on the perception of colours. The symptoms are favourable if the visual field of all the colours has not been much altered, or if its limitations do not correspond with those of the general visual field. But if perception of colours has been lost in a considerable portion of the field, if the boundaries of the visual field of the colours show the same irregularities as the general field, or if certain colours cannot be at all recognized by peripheric vision, the case is proved to be one of progressive atrophy.

The visual field of colours disappears also in alcoholism, in ataxia, and in some affections of the spinal cord.

LECTURE XXII

MOVEMENTS OF THE EYEBALL

Gentlemen,—The form of the orbit is that of an irregular quadrilateral pyramid, with the base directed forwards and outwards. The orbit being completely filled up by the eyeball, the muscles, nerves, vessels, and the lachrymal gland, the globe cannot perform a swinging motion, but its movements are effected by displacement, analogous to that of the head of the femur within the acetabulum, so that when one muscle contracts its antagonist is elongated to an equivalent extent; the form of the eyeball never changes, and there is always equality of pressure within the orbit. The eyeball moves round a common centre, and its movements are effected by six muscles, four straight and two oblique. They all take their origin from the margin of the optic foramen, with the exception of the inferior oblique, which arises from the floor of the fore part of the orbit. The recti are inserted at the anterior half of the globe, at a distance, on an average, of about one fifth of an inch from the margin of the cornea. Near the conjunctival *cul-de-sac* each muscle receives a fibro-cellular sheath, part of a membrane called the "capsule of Tenon," which is a prolongation of the periosteum lining the orbit, and gives off an aponeurosis to cover the orbital muscles, on the substance of which it is ultimately lost.[1] The capsule becomes thickened at the insertion of the tendons, where it surrounds them like a fibrous ring, producing an appearance as if the tendons spread out and coalesced.

The muscles for the rotation of the eyeball are—internal or median rectus, external or lateral rectus, superior rectus, and inferior rectus, superior oblique and inferior oblique. Fig. 109[1] presents a front view of the normal position of the eyeball and muscles in the orbit.

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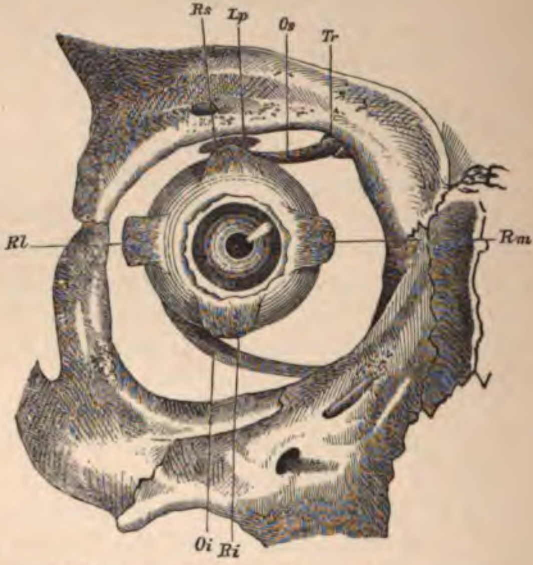
[1] A complete description of Tenon's capsule is given by Richet, 'Anatomie Chirurgicale,' p. 325.

FIG. 109.[1]



Lp, Levator palpebræ superioris cut short. *Rs*, rectus sup.; *Ri*, rectus infer.; *Rl*, rectus lat.; *Rm*, rectus med. *Os*, obliq. sup.; *Oi*, obliq. inf.; *Tr*, trochlea.

1. The internal or median rectus, the strongest of all the ocular muscles, arises in front of the optic foramen, and runs parallel to the internal wall of the orbit. It is inserted into the sclerotic by a tendon, which forms a curved line, the summit of which is in front and on the same level as the centre of the cornea.

2. The external or lateral rectus also arises from the optic foramen, and is inserted into the sclerotic by an arched tendon, having its centre corresponding to the horizontal meridian of the eyeball, hence the action of these two muscles is simple,

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[1] From Merkel, "Macroscopic Anatomy," in 'Graefe-Saemisch Handbuch.'

the internal rectus rotating the eyeball inwards and the external rectus rotating it straight outwards. They move the eyeball on a vertical axis without the slightest deviation and without inclining the meridian, which remains vertical.

3. The *superior rectus*, the smallest of the straight muscles, arises from the margin of the optic foramen, runs parallel to the roof of the orbit, and is inserted into the sclerotic by a curved tendon, whose summit is a little to the inside, hence the action of that muscle turns the cornea upwards and slightly inwards.

4. The *inferior rectus*, arising from the margin of the optic foramen, is also inserted into the sclerotic by a tendon, whose apex is directed slightly to the inside of the vertical meridian, hence, when it contracts the centre of the cornea is directed downwards and slightly inwards.

This somewhat irregular action of the superior and inferior recti muscles is corrected by the action of the oblique muscles thus :

5. The *superior oblique*, or *trochlearis*, is a narrow, elongated muscle arising close to the margin of the optic foramen, whence it proceeds horizontally along the inner wall of the orbit to the inner portion of the superior margin, where it terminates in a tendon, which passes over a pulley (trochlea), and is then curved outwards and backwards at an acute angle towards the eyeball. It passes between the eyeball and the superior rectus, and is inserted into the sclerotic midway between the superior and external recti muscles, nearly equidistant from the cornea and entrance of the optic nerve.

The action of the superior oblique is to draw the superior extremity of the vertical meridian inwards, and thus incline the cornea downwards and outwards.

6. The *inferior oblique*, as already mentioned, is the only muscle of the eye which does not take origin at the apex of the orbit; it arises from a minute depression in the orbital plate of the superior maxillary bone, just within the anterior margin of the orbit, and close to the external border of the lachrymal groove. The muscle inclines inwards and backwards between the inferior rectus and the floor of the orbit, and ends in a tendinous expansion, which passes between the

external rectus and the eyeball to be inserted on the external and posterior aspect of the globe. The convexity of its tendinous extremity is directed upwards and forwards.

The action of the inferior oblique is to incline the vertical meridian outwards, and turn the cornea upwards and outwards, thus assisting, in concert with the superior rectus, in directing the cornea straight upwards. It is evident, therefore, that the action of the superior rectus and inferior oblique are antagonistic in this respect, the former turning the cornea inwards and the latter outwards, but their united action turns the cornea straight upwards, the oblique correcting the inward direction of the superior rectus.

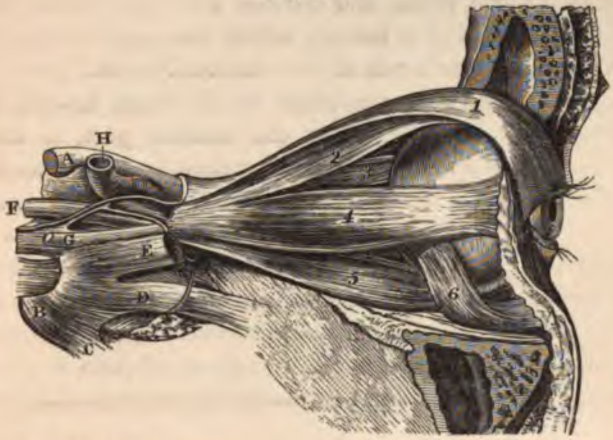
The same relation exists between the inferior rectus and superior oblique; the former corrects the outward tendency of the latter, and thus assists the eye in looking straight downwards.

When, therefore, the eye looks straight forwards in a horizontal plane all the muscles are in equilibrium, and the vertical meridian of the eye is exactly perpendicular. The internal and external recti muscles rotate the eye, the one inwards the other outwards, in a horizontal plane, the superior rectus and inferior oblique rotate the eyeball straight upwards, while the inferior rectus and superior oblique rotate it directly downwards. The simultaneous action of the four recti muscles retracts the eyeball within its socket.

The muscles direct both eyes to the point of fixation in such a manner that the image of the object falls simultaneously on the maculæ of both eyes, and this secures single vision with both eyes, for although each eye receives an image, the sensorium perceives only one object, because the two images are formed on parts of the retinæ which are identical in function, *i.e.* they receive identical and simultaneous stimuli. But if there be the slightest disturbance in the innervation of either eye, so that both maculæ are not fixed on the same spot, double vision (diplopia) is the result, because the sensorium receives the sensation of two distinct images, one of the healthy image, which is impressed on the macula, and another, called the diseased image, which is conveyed to the brain from another part of the retina. These images may be either *homonymous* when they are conveyed on a line with the percepient eye, or they may be *crossed* when the pathological image crosses the healthy image. Further, they may either be on the same level or one above the other. These subjective symptoms of the appearance of the images to the patient is an important guide to us in determining which of the ocular muscles is affected.

Fig. 110 gives a dissection of the muscles and nerves of the eye-ball.

Fig. 110.[1]



1, Levator palpebræ; 2, superior rectus; 3, internal rectus; 4, external rectus; 5, inferior rectus; 6, inferior oblique; A, optic nerve; B, Gassers' ganglion; C, inferior maxillary nerve; D, superior maxillary; E, ophthalmic branch; F, third nerve; G, sixth; H, carotid artery.

The nerves which supply the muscles of the eyeball are:

a. The third nerve or motor oculi, which supplies five muscles, viz. the superior, internal, and inferior recti, the levator palpebræ, and the inferior oblique. It gives also a branch to the ophthalmic ganglion to supply the sphincter iridis.

b. The fourth (patheticus), the smallest of the cranial nerves, is distributed entirely to the superior oblique.

c. The sixth (abducens) is entirely distributed to the external rectus muscle.

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[1] From Jamain. 'Anatomie descriptive.'

d. The fifth (trigeminus) supplies the eyeball with general sensibility, and its ganglionic root imparts to the eye tactile sensibility.

The third nerve (motor oculi) has its apparent or superficial origin from the inner surface of the crus cerebri in the inner peduncular space, immediately in front of the pons. It quits the arachnoid investment, pierces the inner layer of the dura mater close to the posterior clinoid process, and proceeds to the sphenoidal fissure, lying in the external fibrous boundary of the cavernous sinus, and divides near the orbit into two parts (an upper and a lower), which are continued into the cavity between the heads of the external rectus muscle, and are separated one from the other by the nasal branch of the ophthalmic nerve. The *upper*, the smaller part, is directed inward over the optic nerve to the superior rectus muscle and to the levator palpebræ, to both of which it furnishes branches. The *lower* and larger portion of the nerve separates into three branches; of these, one reaches the inner rectus, another the lower rectus, and a third, the largest of the three, runs to the inferior oblique, into which it is distributed. The third gives off a branch to the ophthalmic ganglion, whence it proceeds to the sphincter iridis and the muscle of accommodation.

Paralysis of the Third Nerve

This may be either complete or incomplete, and either one or more branches of the nerve may be affected.

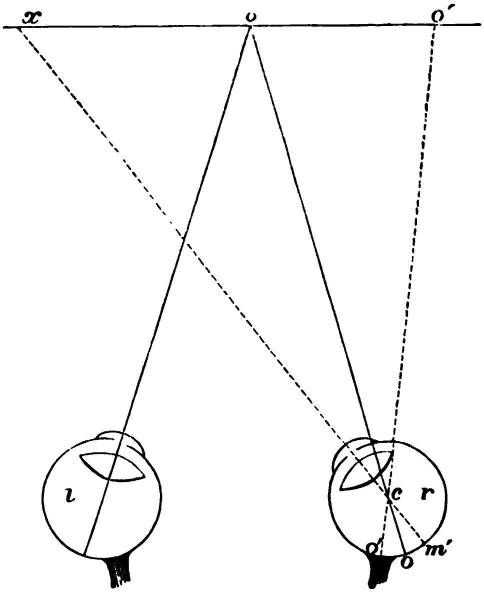
When there is complete paralysis of the third the *tout ensemble* of the symptoms is unmistakeable. There is, in the first place, ptosis (inability to raise the lid), and, the eyeball being entirely under the control of the external rectus and inferior oblique, is directed outwards and downwards. The pupil is dilated and immoveable, and accommodation is abolished, for, as you will remember, the third nerve supplies, not only the sphincter iridis, but also the ciliary muscle. The symptoms in complete paralysis of the third nerve are seen at a glance, and do not require any further investigation.

Incomplete Paralysis of the Third Nerve

The patient becomes aware of this affection when he sees double. The images are crossed, *i.e.* when the right eye is affected the false image of that eye will appear as if it were on the left side, and *vice versâ.* To prove the position of the image you cover the right eye in this case, with a red glass, before which you hold a lighted candle at some distance. The patient sees two flames, a red and a white one, the red being to the left side, and so crossing the image of the normal eye.

The position of the false image, as I have just mentioned, being an important indication as to the nerve affected, you will notice the law which regulates the projection of the pathological image as illustrated in the following diagram.

Fig. 111.



Let *r*, in Fig. 111, represent the right and squinting eye; *l*, the left and healthy eye; *o*, at the top of the diagram, the point of fixation; *m′*, the macula; and *c*, the centre of rotation. The image of *o* is formed upon the macula of the left eye, but in the right eye, the macula having shifted outwards to *m′*, it is formed at *o*, and a line from the macula through the nodal point would cut the plane of the object of fixation at *x*. The patient having been accustomed to have images of objects formed on the macula, imagines that the image is still formed there; this is equivalent to shifting the macula from *m′* to *o*, and consequently the image is also moved from *o* to *o′*. He fancies, therefore, that the light from the object is coming to his eye in the line *o′ o′*, and that the object is situated at the point *o′* at the top of the diagram. He thus sees two objects, *o* with the left eye, and *o′* with the right. In the squinting eye the object is protected in the direction opposite to the deviation of the cornea. Thus convergent strabismus, as in fig. 111, gives rise to homonymous diplopia; divergent, on the contrary, causes crossed images. In paralysis, when the cornea is turned upwards, the false image appears below the real; and when the cornea is turned downwards, the false image appears on a lower level.

You will recognise this affection by the way in which the patient carries his head, which is inclined to the unaffected side in order to escape the double images. The movements of the eyeball will be disturbed according to the branch of nerve affected; thus, when the internal rectus is paralyzed, and when the patient looks straight before him, there is no deviation, but there is inability to look inwards. When the superior rectus is affected there is inability to look upwards, and the image of the affected eye is crossed by and is higher than that of the healthy eye. Again, when the inferior rectus is affected and the eyeball is directed upwards the patient is very much inconvenienced, for it interferes with looking downwards, which is necessary in all occupations, and is principally effected by this muscle.

The inferior oblique is very rarely, if ever affected alone, but generally it shares in paralysis of other muscles.

Cause.—Complete paralysis is generally due to disease of the nerve at some part of its course before it divides into branches, the portion affected being very probably that situated within the cranial cavity. It is believed that the sheath of the nerve becomes thickened, either from an attack of rheumatism, or from syphilis, or from a tumour at the base of the brain, chronic meningitis, or it may be the precursor of locomotor ataxia.

The prognosis is more favourable when the paralysis is unassociated with anæsthesia of the skin of the face of the same side, facial paralysis with vertigo, or other symptoms which point to central lesions, or when only one or two of the branches are implicated. It is more serious when the whole nerve is affected, and especially when a part of the other side of the face is involved, as it implies the presence of cerebral affection.

Treatment.—In recent cases you should order saline purgatives, followed up by iodide of potassium and blisters round the orbit, and watch the case attentively, to make sure that the affection is not central. When this is fairly established the use of vapour baths and the inunction of mercurial ointment to the armpit of the affected side yield very favourable results. This is assisted by galvanism applied to the closed eyelids and round the orbit. I have recently seen very successful results from the use of vapour baths and the oleate of mercury. These results are so striking that, should they be maintained and succeeded by others, we may look forward to the period when we may be able to dispense entirely with the internal use of mercury in the treatment of similar specific cases, or in glandular enlargements. When there is reason to suspect lesions of the brain we must abstain from vapour baths, faradisation, or any irritant whatever, and treatment must be directed to the deeper affection. In cases of old standing, when the external rectus muscle has become contracted, or the internal rectus has been atrophied and the eyeball fixed, an operation for readjustment by tenotomy may be practised.

PARALYSIS OF THE FOURTH NERVE

The fourth nerve, pathetic or trochlearis, is the smallest nerve derived from the brain, and is distributed entirely to the superior oblique muscle. The nerve may be traced backwards round the peduncle to a place below the corpus quadrigeminus, where it arises from the upper part of the valve of Vieussens. According to Kölliker, the fibres of origin are divided under the corpus quadrigeminus into two bundles, the anterior being traceable through the lateral wall of the aqueduct of Sylvius to its floor, where it arises from a grey nucleus close to the middle line, the posterior bundle being derived from a grey nucleus in the floor of the fourth ventricle, close to the origin of the fifth nerve. The roots of the nerves of the opposite sides are connected together across the middle line in the form of a white band or commissure in the substance of the velum.

From the remoteness of its place of origin, the part of this nerve within the skull is longer than that of any other cranial nerve. It enters an aperture in the free border of the tentorium, outside that for the third nerve, and near the posterior clinoid process. Continuing onwards through the outer wall of the cavernous sinus, the fourth nerve enters the orbit by the sphenoidal fissure, and above the muscles.

In the orbit the fourth nerve inclines inwards above the muscles, and enters finally the superior oblique muscle at its orbital surface.

In examining the eye there is nothing to attract the attention of the physician in paralysis of the patheticus. The patient sees perfectly well when looking straight before him, yet the symptoms are peculiar and unmistakeable:—1. The patient carries his head downwards, and to the healthy side, in order to avoid as much as possible looking downwards and inwards. 2. There is no double vision when the patient looks straight before him, but only when he looks downwards, showing at once paralysis of the muscles, which rotate the eyeball downwards. 3. The patient finds great difficulty in walking on uneven ground or in ascending a stair. 4. When the healthy eye is covered with ground glass, and the paralysed eye fixed upon an object, the normal eye is directed downwards and inwards at a greater angle than the angle of displacement of the affected eye. Having thus established that the muscle which turns the cornea downwards and inwards is affected, paralysis of the fourth or paralysis of the inferior rectus must be present. 5. On then examining the double images we find these to be homonymous, and that the healthy image is above the diseased image; hence we conclude that it must be paralysis of the fourth, because in paralysis of the inferior rectus (in which there would be a slight divergent squint) the images would be crossed. 6. The most important symptom in paralysis of the fourth nerve is that the diseased image appears to the patient to be nearer than the healthy image.

The disease may disappear without leaving any trace, or the antagonistic muscle may become contracted.

The treatment is the same as in paralysis of the other nerves.

Paralysis of the Sixth Nerve

The sixth nerve, abducens, takes its apparent origin from between the pyramidal body and the pons Varolii by means of a large and a smaller bundle. It is connected with the pyramid, and to a small extent with the pons also. According to Vulpian and Kölliker, the fibres may be traced more deeply to the floor of the fourth ventricle. The nerve enters the dura mater behind the dorsum sellæ, and, passing forwards in the floor of the cavernous sinus close to the outside of the carotid artery, enters the orbit through the sphenoidal fissure and between the heads of the external rectus muscle, to which muscle it is anteriorly distributed, piercing it on the ocular side.

In paralysis of the sixth nerve the eyeball looks downwards and inwards, and in some cases you may get only a side view of the cornea. There is double vision, the images being homonymous. The remarkable phenomenon connected with this diplopia is that, when you cover the healthy eye, and the patient wants to touch an object before him with his finger, he will always miss it, and touch a point beyond and at the side of the object. This is a fault of exterioration, for as in the healthy eye distance is judged by the force required to exteriorate, and the paralyzed muscle requires an increase of nervous impulse to fix the object correctly, the patient imagines the distance to be greater than it really is.

Paralysis of the abducens is frequently caused by injury to the base of the brain. Jacobi[1] first called attention to this fact, and Panas has lately confirmed it by several anatomical observations.[1] He pointed out why this nerve is more liable to become paralyzed from injury to the base of the brain than any other nerve supplying the ocular muscles. In that part of its course, in which it forms a vertical loop in the floor of the cavernous sinus, close to the carotid artery, it is separated from the bone merely by dura mater, near the sella turcica, which is the place where fracture of the skull generally occurs, and therefore this nerve is liable here to be torn across or otherwise injured.

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[1] 'Graefe's Archiv,' 1867.

The course and treatment of this affection are the same as in the other forms.

Correcting Prisms

The phenomena of double vision may be produced by physiological experiments by looking through prisms.[2] If we place before the right eye a prism with its refracting angle turned outwards the image will be so displaced that the point fixed with the left eye will cast its image in the right eye on the median side of the macula, and produce homonymous diplopia. In cases of homonymous diplopia, therefore, in consequence of disease, we can, by the use of proper prisms, with their refracting angles turned inwards, move the image so far towards the temporal side that it will fall upon the macula; and in like manner we correct cross diplopia by prisms with their base turned inwards. It is not necessary to place the correcting prism before the deviating eye alone; it is generally better to place prisms of equal strength before both eyes.

The use of prismatic spectacles is particularly valuable in cases of paralysis of the fourth nerve.

Disease of the Fifth Nerve—Trigeminus

The study of the trigeminus, the nerve which presides over the nutrition of the eyeball, is interesting in a physiological as well as in a pathological point of view.

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[1] 'Archives d'Ophthalmologie,' Paris, Dec., 1880.

[2] See p. 183.

Magendie was the first experimenter who cut the fifth nerve in the cranium, and at the same time preserved the animal alive, and was able to demonstrate that the fifth is not only a sensitive nerve, but that it has also an influence upon the nutrition of the tissues to which it is distributed. Having witnessed the various experiments of Cl. Bernard[1] on the action of the trigeminus, I deem those researches of importance as having a practical bearing on the study of the various morbid phenomena in the ocular tissues.

The trigeminus arises from the pons Varolii by a larger part (sensitive) and by a smaller (motor) part. The sensitive part passes through the ganglion of Gasser, whilst the motor part has no connection with that ganglion.

The ganglion of Gasser is situated in a depression in the upper part of the petrous portion of the temporal bone, and is somewhat crescentic in form, the convexity being turned forwards. The characteristic feature of this ganglion is that no nerve takes origin from it; hence it may be put into the category of the intervertebral ganglia, and differs from the ganglia of the sympathetic, which generally give rise to nervous ramifications.

Immediately after passing through the ganglion the trigeminus divides into three branches, viz. ophthalmic, superior maxillary, and inferior maxillary. The two superior branches are purely nerves of sensation, whilst the inferior is a mixed nerve, owing to a very thin motor part, which does not enter into the ganglion, and is mixed with the inferior maxillary nerve.

The whole ganglionic part of the fifth nerve presides over the general sensibility of all the organs of sense, of the skin of the face, except the inferior and posterior part of the ear; the motor portion, which goes to the inferior maxillary branch, imparts movement to the muscles of mastication. Thus, when we cut completely the fifth nerve in an animal it loses not only sensibility of the face, but also the movements of the lower jaw, and when both trigemini are cut mastication becomes impossible, and the animal dies of inanition; but when one side only is cut mastication is performed by means of the healthy side.

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[1] 'Leçons sur la physiologie et la pathologie,' vol. ii, p. 31.

Let us consider in detail the effects of the section of the fifth.

When we cut the nerve, immediately the animal utters a loud cry. The eyeball stares out of the orbit. When the cornea is touched there is no winking, for sensibility is lost. Loss of vision does not follow, however, immediately. Irritate the nostrils or prick the lips, jaws, or face, and there is no manifestation of sensibility, which is completely lost in these parts on the same side as the section. The ear alone is sensitive, for its sensitive nerves are derived, not exclusively from the fifth, but also from the cervical plexus and from the pneumogastric.

Two days after the section, the conjunctiva becomes red and injected; an opacity becomes also visible at the same time upon the cornea. The cornea is also arched forward—becomes more convex; the iris has changed its colour (chagined). It has been proved by other experiments that these changes in the cornea and iris are due only to the section of the fifth nerve. Some days later the engorgement of the conjunctiva augments; the cornea becomes more opaque, and begins to ulcerate. There are, in short, supervening inflammatory symptoms, without pain or heat, the temperature being, on the contrary, lower on the side operated on. Pus appears in the anterior chamber, the cornea becomes perforated, the lens is evacuated, and the eyeball shrinks. There is also discharge (running) from the mouth and nose, and ulceration of the tongue and lips, and the movement of the jaw is affected; the teeth of the upper and lower jaws are not brought properly in apposition. Generally the animal does not survive more than a fortnight.

We notice further that the symptoms manifested by the animal differ according as the section is made before the nerve enters into the ganglion or after its emergence, or when cut upon the ganglion. When cut before the ganglion the phenomena of altered nutrition are slower than when cut upon or beyond the ganglion, which shows that the ganglion is mainly concerned in the process of nutrition. This is quite in accordance with the characteristic of the intervertebral ganglia.

It is rarely that we have an opportunity of observing a case of disease of the trigeminus. In the Aberdeen Royal Infirmary I noted a case along with my friend Dr Beveridge, who published the details of it.[1] I shall therefore submit to you Dr Beveridge's record, which is exceedingly interesting, because the case exhibited nearly the same train of symptoms as produced by Cl. Bernard by experiment upon animals; only in the case of our patient the symptoms came on gradually, the insensibility stealing on slowly over the face, almost as the shadow does over the sun in an eclipse. This gradual approach corresponded with the post-mortem appearances, which seem to show that different parts were not affected simultaneously, but in succession—first the trunks of the nerve, then the ganglion, and in each of these first the upper and inner part, and lastly the lower and outer. Thus, as thread after thread became involved, the insensibility, beginning in the forehead, gradually spread down over the face until the whole was affected.

Case.—Andrew B—, age 45, was admitted into the Royal Infirmary, complaining of anæsthesia of the left side of the face, affecting the brow, eyelids, eye, nose, and upper lip, these parts being completely insensible when touched, and partial anæsthesia of the lower part of the face, where sensation was much dulled but not completely lost. There was no motor paralysis of the features, and on his admission no motor paralysis of the muscles of mastication. He stated that these symptoms had come on gradually, beginning with the feeling of prickling in the parts affected, followed by numbness, and finally complete loss of sensation. After admission the disease continued to progress, involving the whole left side of the face, and producing also motor paralysis of the muscles of mastication of that side. The symptoms then present might be summed up as follows:—Entire loss of sensation on the left side from brow to chin; conjunctiva and cornea of left eye completely insensible, no winking being produced by touching them, although the eyelid could be freely opened and closed at will; left nasal cavity and left half of the tongue considerably impaired in sensibility, but not absolutely destitute of it; sensation in the left auricle impaired but not lost; hearing of that side impaired. It was not satisfactorily determined whether the senses of smell and taste were lost on that side or not; both seemed to be impaired.

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[1] 'Medical Times and Gazette,' February 22nd, 1868.

The vision of the left eye began early to be impaired, and finally was completely lost, the transparent media becoming opaque, and finally hypopion appearing.

There was considerable emaciation of the left side, and although the jaw continued to be moved by the muscles of the opposite side, yet the muscles of the affected side could be felt quite flaccid during these movements, and finally wasted considerably. The movements of the eye and those of the features were perfectly preserved. Lastly, the patient became dull and languid, partial loss of power over the muscles generally followed, and he gradually sank.

Post-mortem appearances.—At the left side of the base of the skull was found a tumour on the trunk of the fifth nerve, where it issues from the pons, and lying between the pons and the petrous portion of the temporal bone. This tumour was of a greyish colour, firm in texture and conical in form. The narrow end, pointing outwards and backwards, corresponded to the point of emergence of the nerve from the side of the pons, while the anterior end, broad and blunt, lay immediately under the posterior clinoid process, and formed an indentation on the surface of the pons inside it, without, however, being in any way adherent to it. The tumour measured about an inch in length, was enclosed in a tube of arachnoid membrane, like the nerve in which it was evidently formed, and was in no way adherent to any of the surrounding parts. From the middle of the outer side of the mass issued the nerve, of about its normal size, but firmer and harder than usual, passed under the edge of the tentorium, and then expanded into a flat, firm, somewhat oval mass, being the Gasserian ganglion enlarged, intermixed with fibrous tissue, and crowned with firm, adherent dura mater. This mass extended forwards nearly to the sphenoidal fissure, measured 0·9 inch in its greatest transverse diameter by 0·65 inch in its antero-posterior, and involved not only the ganglion itself but also the ophthalmic branch, the commencement of the superior maxillary, and partly also the inferior maxillary.

Close to the sphenoidal fissure the ophthalmic nerve, still larger than usual, lapped over the fourth nerve, concealing it from view, but not adhering to it, while underneath the latter lay the third and sixth nerves as usual. None of these, at any point of their course, were involved in the disease. The internal carotid artery adhered slightly to the under surface of the mass, but retained its natural calibre. The right crus cerebri, at its upper part, where it entered the optic thalamus, was thickly studded with bloody points, around which the tissue was softened. The same appearance occurred on the left side, but to a much greater extent, extending into and involving the lower half of the optic thalamus, together with the greater part of the crus cerebri. Rest of brain healthy; orbit, nasal cavity, and mouth healthy.

That sensation was not completely lost in the auricle, nasal cavity, and tongue, points out that these parts do not depend for their sensibility exclusively on the fifth nerve, the auricle receiving, in addition, the auricular branch of the cervical plexus, the nasal cavity, the olfactory and nasal branches of Meckel's ganglion, the tongue, the glosso-pharyngeal, and perhaps branches from the submaxillary ganglion; but the great impairment of sensibility manifested in the two latter situations shows that it is to the fifth nerve they mainly owe their power of sensation.

Another point of interest in this case refers to the impairment of nutrition, as it supports Bernard's view that, while the nerve itself, through its connection with the brain, is the immediate channel of sensation and motion, it is the ganglion which directly presides over nutrition.

The non-occurrence of ulceration of the cornea, lips, and tongue, which so usually follows section of the nerve, would, at first sight, appear to favour Labord's recent experiments, referred to above (page 76), that Bernard's operation produced other lesions besides the nerve section. But I cannot admit that supposition; having witnessed Bernard's experiment, and examined the animals at the post mortem, I satisfied myself in every case as to the nature of the lesion produced.

It is possible, however, that the different results obtained by Bernard and Labord are owing to the nature and strength of the animal. In a big strong rabbit the cornea would become opaque but would not ulcerate, whilst in a feeble animal ulceration would be induced; thus, also, in the human subject, in the case of the patient noted by Bernard in the Salpêtrière, there was ulceration of the cornea; for it is only old, debilitated persons who congregate in that hospital, whilst in our sturdier patient, a man of forty-five, there was only opacity, but no ulceration, although the eye was full of pus.

The occurrence of deafness towards the end of the disease, though interesting as showing the intimate connection of the fifth nerve with all the senses, does not admit of so obvious an explanation as the other symptoms. The auditory nerve and the labyrinth were in no way affected, so that the deafness seemed to be due to the condition of the tympanum. These muscles (levator and tensor palati) receive filaments from the fifth, both directly and indirectly—directly from the lingual nerve, and indirectly through the otic ganglion. The circumstance of the deafness following the paralysis of the muscles of mastication would seem to connect it with paralysis of the motor root of the nerve, and so strengthen the above explanation.

The lingual nerve is usually regarded as a sensory nerve; but it would thus seem probable that, like the other large branch of the inferior maxillary—the dental, with its motor mylo-hyoid branch—the lingual, though principally sensory, contains also motor filaments.

The affection of the crura cerebri occurring on both sides was probably independent of the lesion of the fifth nerve.

LECTURE XXIII

STRABISMUS—SQUINT

Gentlemen,—In the preceding lecture I explained to you the mechanism by means of which simple vision is effected with both eyes. The muscles direct both maculæ to the point of fixation, and, these being identical in function, receiving simultaneous stimuli, the sensorium takes cognizance of one impression only. But, if there be a disturbance in the innervation of the eye, so that both maculæ are not fixed on the same point—as is the case in paralysis—simple binocular vision becomes impossible, and double vision is the result. Now, strabismus is that condition of the eye in which, in consequence of some defect in the nervo-muscular apparatus, the visual axes do not intersect at the fixed point, and hence the object casts its image upon the macula lutea of the one eye, while in the other it falls upon some eccentric part of the retina.

The question, then, which will naturally suggest itself to you is, Why do persons affected with common squint not see double? The explanation commonly given is that in every case of strabismus double vision is at first produced; but after awhile the patients train themselves by a psychological process, to suppress the image received by the deviated eye, and take cognizance only of that, conveyed by the healthy eye. It is further assumed, according to this theory, that when the attention is concentrated in the eye used for fixation, the ease with which the image in the squinting eye can be suppressed depends on its eccentricity, *i.e.* its position in a less sensitive part of the retina. But precisely the same conditions are present in paralysis, and they do not prevent double vision.

It is, moreover, admitted that the squinting eye does contribute toward widening the field of vision, and hence the image is not suppressed in peripheric vision. Schweigger has further proved that even the part of the retina used for fixation is not suppressed by the following experiment:—Let the patient's eye used for fixation be directed upon a light in a median plane and on a level with itself, and be covered with a red glass; let another smaller light be held behind and at the side of the squinting eye, before which a transparent plane glass is held, in such a manner that the reflection of the second flame is seen upon the cornea. As soon as the plane glass is turned in such a manner that the corneal reflection is brought into the area of the pupil the patient sees two flames; one is red—that of the eye in fixation—and the other is seen only by the squinting eye. By a peculiar turning of the plane glass both flames can be brought either close to each other, or be made to coalesce. As soon as the glass is so turned that the corneal reflection does not fall into the area of the pupil, the light disappears from the patient's sight.[1] This experiment is altogether of an objective character, and affords a positive proof that in binocular vision there is consciousness of the retinal impression made in the squinting eye. Any explanation, therefore, based upon the theory of unchanging symmetrical correspondence of the retina, is untenable.

Schweigger's theory is more plausible. He maintains that the relations of the corresponding retinal parts are not congenital but acquired, and that we place both maculæ opposite the object fixed from habit acquired by experience, in consequence of physiological preference in respect to acuteness of vision. When binocular fixation is once established the symmetrical points of the retinæ first acquire the significance of correspondence, and hence a disturbance in the correspondence causes diplopia. But, if from any cause whatever binocular vision be relinquished in early childhood, as in the case of squint, which generally commences between the age of two and seven years, no habit is developed of uniting the two retinal images, but each eye projects its field of vision in the proper manner, each for itself sees the object in the direction towards which it is turned; and there is no diplopia in these cases, because that depends on a previous habit of uniting the two fields of vision. If binocular union of the two retinal images never become a practice then there will be no diplopia when the field of vision in the one eye is moved up or down by a prism refracting vertically, and such is the fact in many cases of strabismus.[1]

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[1] 'Handbuch,' p. 9, 4th Edition, 1880.

When the image of the deviating eye falls inside the centre (macula) it produces a convergent squint, and when the image falls outside the macula it gives rise to a divergent squint. Deviation upwards or downwards alone is very rare, and when it does occur it is in connection with convergent or divergent squint.

I must, however, add, in connection with this view of the subject, that we sometimes meet with cases of strabismus, coming on at a period of middle age, without diplopia. At present (May, 1881) we have two such cases under treatment. Here is another case: Mr Donald C—, aged 46, recommended by Dr Macdonald, of Inverness, who is suffering from epileptic attacks, coming on once in two or three months. He first became subject to these attacks twelve years ago. Only lately he commenced to be troubled with a convergent squint of left eye, without diplopia. Retina and optic nerve are healthy.

Cause.—Donders has facilitated the study of strabismus by showing it in its intimate connection with the anomalies of refraction. He has found that 77 per cent. of cases of internal squint are dependent on hypermetropia.[2]

It is effected by the following mechanism:—The hypermetrope has to call in the aid of his accommodation for seeing even distant objects distinctly, and so his ciliary muscle is still more taxed when looking at near objects; he is thus compelled, in near vision, to exhaust his available power of accommodation. During this act he requires also the aid of the internal recti muscles to cause both eyes to converge, for there can be no accommodation without convergence. Now, convergence is effected to a greater extent with one eye than with both; he therefore spares the fatigue of his ciliary muscle at the expense of convergence, and thus gets into the habit of using only one eye for fixation, sacrificing binocular vision for the sake of sparing the tension of his accommodation. It is remarkable to notice that it is not the higher degrees of hypermetropia which induce divergent squint, but rather the medium and slighter degrees. This is easily explained, for the advantage, just referred to, of working with a relatively slight tension of accommodation is purchased at the expense of binocular vision; hence in the higher degree of hypermetropia, when, notwithstanding too strong convergence, no distinct retinal image can be obtained, there is no inducement to sacrifice binocular vision. In the medium and lower forms of hypermetropia, however, there exists the inclination to exchange binocular single vision for a convenient monocular fixation, when any cause whatever makes binocular fixation less valuable, as is the case in differences in refraction, or in acuity of vision of the two eyes.

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[1] Schweigger, loc. cit.

[2] De Wecker found that of every hundred cases of convergent squint eighty-five are hypermetropic, ten have unequal refraction, three myopic, and two emmetropic.

In like manner, divergent squint is induced by myopia, for a myope requires but little accommodation; he has no need for the action of the ciliary muscle in looking at near objects, and therefore he has no need of convergence. In looking at near objects his eyes are nearly parallel, while in distant vision a further relaxation of the internal recti takes place, and divergence is the result. In some cases divergent squint is caused by an elongated myopic eyeball; convergence is mechanically impeded, giving rise to insufficiency of the internal recti muscles. Cases, however, do occur of strong myopia with convergent squint. Two such cases are under observation where there is myopia = 6 with posterior staphyloma and convergent squint.

Besides the cases connected with the anomalies of refraction, strabismus may be induced—

(*a*) By defective sight in one eye;

(*b*) By opacities of the cornea or of the lens capsule;

(*c*) By irritation from ascarides after convulsions from dentition; or

(*d*) When one of the muscles has been weakened by paralysis.

Strabismus may be either *monocular* or *alternate*. It is called *monocular* when only one eye is deviated, and alternate when the patient squints first with the one eye and then with the other. Hypermetropic squint is a good example; thus, when refraction in both eyes is equal, the patient converges one eye alone for fixation, and, as he can fix with either eye—and it is only their associated movement which he avoids as being inconvenient—he acquires the habit of fixing either with the one or with the other. On the other hand, when refraction is unequal there is a strong contraction only of one eye.

You may notice, also, that when a squint is very strongly unilateral, the other eye is generally slightly deviated, and this we call concomitant squint. This form is of most frequent occurrence.

Strabismus is said to be *intermittent* when it is interrupted by a series of efforts to accomplish the act of binocular vision, which, however, cannot be maintained for any length of time; and *permanent* when ultimately those efforts terminate in complete abolition of binocular vision. As a rule, every intermittent form ends in a permanent squint. The residuum of muscular paralysis, when the muscle has not quite recovered its strength, is one example of this form of squint, and another is found in cases of myopia, when there is a congenital weakness of the internal recti muscles, and there is, from this cause, no effort at binocular vision.

These remarks with regard to the nature and genesis of strabismus will enable you more readily to appreciate the different forms of squint with the view of effecting their cure. When a patient presents himself with squint you will ascertain—

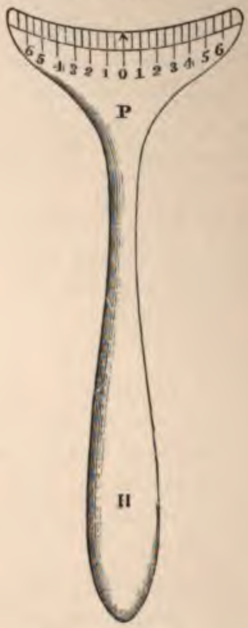
1. Is it periodical or permanent? If only occasional it is very likely due to ascarides, or to irritation from dentition. If permanent, is it owing to an anomaly of refraction or to defective vision in the squinting eye?

2. Examine the movements. In some cases the movements

of the squinting eye are limited; in convergent strabismus the range of excursion of the globe outwards is impeded, and in divergent squint its range of movement inwards is arrested. In a large majority of cases, however, the movement in the squinting eye is not limited but merely displaced.

3. Measure the degree of the deviation. To ascertain this the patient is ordered to look at an object about twenty inches distant, when it will be found that while he fixes with one eye the other rotates inwards or outwards, according to the nature of the squint. Fig. 112 represents a very convenient little instrument devised by Z. Laurence for the purpose. It is an ivory plate moulded to the conformation of the lower eyelid, the free border corresponding to that of the lid. This border is graduated in such a manner that while its centre is designated *zero*, lines are marked off on each side of this point. If the cornea is central the vertical diameter of the pupil corresponds to zero; if inverted, it is turned to the graduated

Fig. 112.



scale on the inner side of zero, if everted to that of the outer side. It is applied in the following manner:—The eye generally used for fixation is covered with ground glass, and the object is fixed with the squinting eye and the division of the scale under the centre of the pupil noticed; the other eye is then uncovered, and the former allowed to resume its ordinary squinting position, and it is again noted which division is exactly under the pupil. The difference between these two measurements is the linear deviation.

4. Notice, also, the movements of the squinting as well as of the sound eye under the ground glass. First cover the eye, which is generally in fixation, with the ground glass, and make the squinting eye fix upon an object; then treat the sound eye in a similar manner, and see their respective behaviour when thus under cover. We call the movement which the squinting eye makes when the healthy eye fixes on an object the *primary* deviation, and we call the extent of movement which the sound eye makes, when covered by the ground glass, while the squinting eye alone fixes on the object, the *secondary* deviation; and you will notice that the characteristic feature of concomitant squint is, that the degree of the secondary deviation is identical with the degree of the primary deviation.

Treatment.—When strabismus is owing to hypermetropia an attempt should be made to prevent or relieve it by correcting the refraction. Generally, however, the extreme youth of the patient renders the use of spectacles impracticable; and in adults the established squinting habit has already induced shortening of one muscle and lengthening of its antagonist to such an extent that the use of spectacles will not relieve it. If the squinting eye be not amblyopic it might, in rare cases, be improved by separate practice, the patient looking with that eye alone, aided by the application of eserine;[1] but, as a rule, an operation is the only means of effecting a cure.

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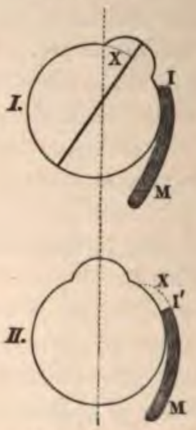
[1] ℞ Sulph. Eserine, gr. ij;
Aquæ destil., ℥j. M.

Three drops into the eye, to cause contraction of the pupil. Its effects last an hour or two at first; after application for some weeks the pupil remains longer contracted.

Operation.—The operation for strabismus was first introduced by Stromeyer in 1838, and in the following year it was practised methodically by Dieffenbach. It has since undergone various modifications, and we have now arrived at the conclusion that the object of the operation ought to be merely to shift the tendinous insertion of the shortened muscle, without interfering with its connection with the eyeball by means of the capsule of Tenon and conjunctiva. For this purpose we divide the tendon close to its insertion on the sclerotic, and, by shifting it a little backwards, modify its effect upon the displacement of the centre of the cornea. Fig. 113 shows how this effect is produced in a case of convergent squint. After the detachment of the tendon from its insertion the muscle retracts as far as its tension demands and its connection with the capsule of Tenon and the conjunctiva allows, while the external rectus and the oblique muscles draw the eyeball round until equilibrium is reached. After some days, union takes place between the muscle and the sclerotic, in a line parallel to the original insertion, but a little back.

FIG. 113.[1]



I, shows the position of the globe before the operation; and *II*, after. I, is the insertion of the muscle in *I*, and I′ in *II*; the muscle having retracted from X as many mm. as the ball deviated.

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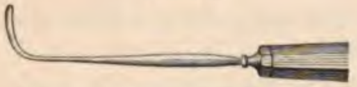
[1] From Alfred Graefe, 'Motilitäts Lehre,' p. 80.

OPERATION FOR CONVERGENT SQUINT

I give chloroform only to children, preferring to operate after the age of fifteen without chloroform, as it enables me to test the result of the operation immediately, and to adjust the eyeball properly.

The patient having been placed in a recumbent position, the lids are held open by a speculum, the conjunctiva and subconjunctival tissue are seized with forceps about one centimètre from the cornea, at the border of the insertion of the internal rectus, and with straight probe-pointed scissors a small incision is made into these tissues, so as to expose the tendon of the shortened muscle. The hook (Fig. 114) is then introduced, its point being applied close to the globe, a little to the outside of the tendon, then, sweeping round and keeping the flat end close to the ball, the hook is insinuated under the tendon, which is entirely embraced and thus fixed; the eyeball being rotated slightly downwards and outwards, these structures are then lifted from the tendon with a small hook, without tearing them, and the tendon cut close to its insertion. To make sure that all the fibres have been cut, I introduce the small hook from the upper side of the wound, and glide it along the whole extent of tendon, to find if any resistance is offered to its course; the displaced conjunctival fold is then allowed to fall back upon the cut tendon. We examine immediately the effect of the operation and the extent of the correctness of movement of the muscle which we have obtained. If the result be not sufficient some tendinous fibres must have been left uncut, and these must be taken up again with the hook and divided. Should the eyeball rather be inclined to abduction, a ligature, by means of which the effects of the operation can be regulated, is introduced through the conjunctiva and subconjunctival tissue.

FIG. 114.



Dressing consists of warm water or an infusion of camomile, dry lint, and a bandage applied to the eye operated upon.

The patient is ordered to apply the bandage to the other eye, and look about with the eye operated upon, several times in the course of the day, in order to accustom the tendon to its new insertion.

I never operate upon both eyes at the same time. Even in a high degree of strabismus, when it is evidently necessary to divide the operation between both eyes, I prefer operating first on the one, watching its effect, and after some days operating on the other.

CRITCHETT'S SUBCONJUNCTIVAL OPERATION

Is performed in the following manner:—The lids are held open by a speculum. The conjunctiva and the deep fascia are laid hold of, over the lower edge of the insertion of the rectus tendon, and a small opening made with probe-pointed scissors through both these structures. The hook is passed through the opening thus made and behind the tendon. The points of the scissors are then introduced and slightly separated. One blade is passed along the hook behind the tendon, and the other in front of it, when, by a succession of small snips, the tendon is cut subconjunctivally on the ocular side of the hook.

Before withdrawing the speculum Mr Bowman usually makes a small counter-puncture in the conjunctiva by bulging it on the end of the hook, the object being to allow any of the effused blood immediately to escape, as otherwise it is apt to be diffused.

My operation has all the advantages of a subconjunctival section. The whole of the blood escapes, and there is very little trace of it to be seen after three or four days. The operation sometimes requires to be repeated.

The result of this operation for convergent squint is nearly always highly satisfactory as regards the improving of the appearance. In cases of squint caused by hypermetropia, refraction must be corrected by means of suitable glasses. When some tendency to squint is left it is recommended by some to counteract it by wearing the spectacles in such a manner as to force the eye slightly into abduction. It must, however, be done in such a slight degree as not to induce fatigue.

With regard to the question as to whether we establish binocular vision and improve the sight of the squinting eye by the operation, I am inclined, from personal observation, to think that only in those cases where the deviation has been induced by contraction of the muscle as the result of convulsions, or, when congenital, by abnormal insertion of the tendon, and when acuteness of vision in both eyes is not interfered with, binocular vision may be established; but when the squint is caused by defective vision in the one eye we obtain only an improved appearance, and no more can be expected.

Operation for Divergent Squint

In this form of deviation of the eyeball, after the section of the external rectus tendon there is, as you will remember, not only the internal rectus but also the superior and inferior recti muscles to rotate the eyeball inwards, and to establish the equilibrium. But, as a rule, the result of tenotomy of the external rectus is not satisfactory. When divergent squint is associated with a high degree of myopia, the long axis of the eyeball, and its being firmly confined within the capsule of Tenon, offer an impediment to convergence. In many cases, again, vision is highly defective, and the internal rectus is too much stretched to produce the desired effect.

The only operation suitable is that proposed by Critchett for bringing forward the insertion of the internal rectus muscle, after strong deviation has been produced by an operation for divergent squint. It is performed in the following manner:—The lids are kept open by a speculum; the eyeball drawn inwards. A vertical incision is then made with scissors through the conjunctiva and subconjunctival tissue, in a line corresponding to the inner margin of the cornea and about two lines from it. Then the conjunctiva and the subconjunctival tissue, along with the new insertion of the internal rectus, are to be separated as far back from the inner side of the globe as the caruncula. A vertical slip of the conjunctiva and fascia is now to be cut away, and the edges of the wound to be brought accurately together with three sutures. The central one is inserted first, and it should be passed through the slip of conjunctiva which was left at the edge of the cornea, and through the conjunctiva and deep fascia close to the caruncula, so that, when fastened, the eye will be drawn inwards and the caruncula raised. The upper and lower stitches are next to be introduced, and an assistant then gently inverts the eye whilst the threads are being tied. When the operation is completed the eye should have a decided internal squint, as the after result is always considerably less than that which is obtained at the time.

For the first twenty-four hours after, lint dipped in cold water should be applied over the closed lids. The stitches are removed on the sixth day after the operation.

NYSTAGMUS

This is a continuous oscillating movement of the eyes, generally in a horizontal direction, and effected by the external and internal recti; but sometimes it takes the form of rotation under the influence of the oblique muscles. It may be accompanied by oscillation of the head. In most cases it is congenitally allied to amblyopia, as a sequela of ophthalmia neonatorum, or keratitis, when the cornea is partially opaque, congenital or zonular cataract, or pigmentous choroiditis. Although nystagmus is almost incompatible with normal acuteness of vision, yet it is remarkable how well such patients see, notwithstanding the constant shifting of the images, the patient becoming accustomed to and disregarding them. There is another form of nystagmus, which occurs amongst miners, and which is caused by protracted work underground in the light of a lamp fixed upon their heads, the eyes being constantly strained in certain directions. It comes on after working for a lengthened period in darkness. In daylight, vision and ocular movements are normal, but the oscillations come on again in twilight, and gradually become associated with decrease of retinal sensibility, retinal torpor, or hemeralopia; the patients are annoyed and made dizzy by the apparent movements of objects. It is interesting to contrast this form of the disease with the congenital form. In the latter the patients have learned by experience, according to the empyrical theory of vision, that the movements of the images upon the retina do not belong to the object; but in the form of nystagmus, which appears at a later period of life, when normal vision has once become habitual, the movements of the image will be referred to those of the object, and cause giddiness.

Treatment.—Absolute rest to the eye, combined with tonics and the use of galvanism, may be tried.

LECTURE XXIV

INJURIES OF THE EYEBALL

Gentlemen,—Bruises of the eyeball with the thumb or with a stick, when inflicted either directly upon the ball or through the lid, give rise to—

1. Bloody effusions into the anterior chamber (hæmatopia).
2. Tremulous iris, caused by rupture of the zonula.
3. Rupture of the sclerotic.
4. Softening of the vitreous.
5. Detachment of the retina.
6. Softening and disorganization of the ball.

Treatment.—When the hæmorrhage is inconsiderable, it generally absorbs in a few days. But when it is abundant, it is best to remove it by a paracentesis, for a large clot in the aqueous chamber may take a long time (generally weeks) to absorb, during which period the iris may become adherent and other tissues suffer in the process. You will notice that hæmatopia, when occurring spontaneously, is a very bad symptom, indicating the presence of a disorganizing process. Blind eyes of long standing are generally subject to it.

In cases of rupture of the zonula, detachment of the retina or any serious internal injury, the eye should be treated by fomentations and atropine, and be carefully watched for a considerable time, and after the first inflammatory action has passed off, must be dealt with according to general principles.

A stroke upon the eyeball may produce rupture of the sclerotic and irremediable blindness or partial staphyloma of the ciliary body. If the staphyloma is of slight extent and causes no pain it may be left alone, but if considerable it causes intense supra-orbital pain, which may be relieved by paracentesis, or if the iris bulges too much, and the pupil is dragged towards the wounded side, a counter-iridectomy may be performed to relieve tension. Here are two cases just now (Sept. 17th, 1881) under treatment.

CASE 1.—A woman, who had interfered in a struggle between two men, got a stroke with a leather strap upon the eyeball. Acute glaucomatous symptoms set in at once, and a week later the lens became opaque and vision entirely abolished.

CASE 2.—A rivetter received a stroke with a piece of iron upon the eyelid. An indentation is visible at the corresponding part of the eyeball, one-sixth of an inch from the corneasclerotic junction, and the injury has resulted in detachment of the retina.

GUNSHOT WOUNDS OF THE EYEBALL

The strange courses which pellets and percussion caps take are well known. The latter sometimes lodge in the lens, having passed through the cornea; the former, again, may come through the sclerotic and lodge in the orbit, or striking upon the wall of the orbit, travel round to the inner canthus and lodge superficially.

Treatment.—In all cases where a pellet has traversed the eyeball the eye must be sacrificed. It is quite different with a piece of percussion cap. It may be lodged in the lens, in which case it is removed along with the cataract, but when it has entered the sclerotic it cannot fail to lacerate the choroid, produce choroidal hæmorrhage, lodge in an inaccessible spot, and cause sympathia. In such a case the eyeball must be removed.

Similar injuries to the eyeball may be caused by other foreign bodies entering the eye. I have reported[1] a case of a minute particle of iron, which had been struck off a nail, having lodged in the sclerotic, close to the optic nerve, for upwards of eight years. The eye gradually became blind, but the foreign body remained quiescent during the whole of that period, and then suddenly caused uneasiness in the other eye, upon which I had to remove the injured eye.

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[1] 'Medical Times and Gazette,' January, 1876.

Gunpowder explosions may produce instantaneous blindness by the shock, but sometimes, again, the powder and bits of stone or rubbish enter the cornea and lodge in the lens, producing cataract. I have recorded two cases in which the lens was successfully extracted in such circumstances.[1] In both of them I found the capsule very hard, so that it was difficult to make an impression on it by the cystotome. As the cornea is generally extensively opaque, you must make the iridectomy face the transparent portion of the cornea.

INJURIES IN RAILWAY COLLISIONS

In addition to the ordinary injuries to the eye, arising from wounds or contusions in the neighbourhood of the orbit, railway collisions may cause impairment or abolition of sight by blows on the head. We may thus have mydriasis and paralysis of accommodation—paralysis of one of the nerves which move the eyeball—softening of the vitreous—detachment of the retina—hæmorrhage in the brain, causing amblyopia, or giving rise to a disturbance of vision, which cannot be discovered by the ophthalmoscope. The vague notions which prevail upon the subject have caused some parties to imagine that deterioration of vision may easily be simulated. In some cases there is no doubt that the persons have been shaken, have simply got frightened, and honestly imagine that their vision has become dim, but there are not wanting others which must be regarded as cases of pure simulation. If the ophthalmoscope does not show any sign of injury, we have the perimeter and the tests with lenses and prisms, and we may, in every case, ascertain whether the person gives a coherent account of the condition, and whether the subjective symptoms are consistent with or contradictory of each other or with the ascertained facts of the case. Into such incoherency or contradiction a non-professional man is sure to fall. Some cases, however, do occur in which, owing to the pre-existence of pathological conditions, the question of injury is very difficult to decide.

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[1] 'Report of International Congress,' London, 1873.

INFLAMMATION OF THE ORBIT

This small cavity—the orbit—is a highly vascular region. Besides the ophthalmic artery and its branches, there are numerous anastomoses coming from the external carotid. The orbital veins proceeding to the jugular form a rich venous plexus, and the region is also rich in lymphatics. Yet, comparatively speaking, inflammatory processes of the orbit are not very common.

All the tissues in the orbit may be inflamed, either singly or simultaneously. Thus we have—

1. Inflammation of the cellular tissue (*orbital cellulitis*) and induration of the cellular tissue—acute and chronic abscess.
2. Inflammation of the periosteum and bones—caries and necrosis of the orbit.
3. Inflammation of the vessels (*anglioleucite*)—phlebitis—arteritis—aneurism of the orbit.

Inflammation of the cellular tissue of the orbit sets in with dull, then throbbing and intermittent pain in the back of the eye extending to the head. This becomes continuous, acute, and augmented by pressure. The progress of this condition advances towards participation of all the tissues of the eyeball (*panophthalmitis*). The eyelids become tumefied, the conjunctiva œdematous, the sclerotic vascular, and the iris discoloured. There is a feeling of fulness in the eye, and the ball protrudes. There is retinitis and intense photophobia; very soon the conjunctiva becomes elevated and suppuration shows itself. The disease pursues a rapid course, and unless prompt measures be adopted blindness soon takes place. Acute orbital cellulitis is well marked in its symptoms and cannot easily be mistaken.

If resolution is to take place, it occurs in the course of a few days, but if the case is to end in suppuration it may last some months, according to the depth as well as the nature of the inflammation, whether it be acute or chronic. In cases of suppuration, there supervenes a feeling of heaviness in the eyeball with occasional rigors, the ball protrudes and deviates, the conjunctiva is œdematous, then serous chemosis follows, pus issues, the abscess opens, and discharges pus either alone or mixed with sloughs of cellular tissue. When the inflammation is limited, vision may not be compromised, but the case is serious, when vision is lost to a considerable degree, and the suppuration may extend to the meninges.

Chronic Abscess

Is accompanied with dull pain throughout its whole course. It does not generally affect the entire cavity but is limited to one spot, so that in many cases it is difficult to distinguish it from tumour in that region, and very eminent surgeons have been chagrined to find their diagnosis of tumour falsified, the abscess bursting, and the condemned eye recovering. It generally affects cachectic subjects. These abscesses are comparatively free of danger, but they may form complications and give rise to induration of the tissues of the orbit.

Treatment.—At the commencement of the disease warm fomentations, hot poultices, mercury, and belladonna ointment round the orbit, are applied (leeches are also recommended). Purgatives are followed by quinine and small doses of blue pill. The directions generally given are:—As soon as the abscess has formed it should be opened in the most bulging part of the orbit, but I agree with Mackenzie, that it is better not to wait until it bulges. As soon, then, as I am satisfied, from the symptoms, that suppuration is to be the result, I make a deep incision with scissors into the conjunctiva and the fibrous sheath of the orbit. This never fails to give relief and to prove advantageous in the subsequent stages of the affection. The opening thus made allows the tension of the parts to be directed to it, and relieves the pressure upon the optic nerve, which is apt to be stretched by the protrusion of the eyeball. We notice in such cases that the eyeball very rapidly retracts within the orbit after such an incision. I would apply this treatment only to healthy persons; in scrofulous or syphilitic cachexia I would by no means use an instrument.

When pus has formed, a free incision becomes necessary, to give issue to the discharge. The retina and optic nerve soon recover their functions after the eyeball has withdrawn into its normal position. Sometimes, however, there is a slight amblyopia remaining, the organ is weakly, vision is more or less impaired, or the movements of the eyeball may be limited in some directions. This is especially the case when there is any induration of the deep cellular tissue, or stiffening of the muscles which rotate the eyeball.

Cause.—The causes of orbital inflammation may be either *idiopathic* or *traumatic*. Among the idiopathic may be classed cold, from a person getting a chill after being heated. I have seen it attack a person who had fallen asleep at his work in a damp place, or who had been exposed to a draught during night travelling by railway. But more generally it is owing to traumatism, as in cases of contusions, wounds, fractures implicating the bones of the orbit, the presence of foreign bodies, or in operations upon the orbit. In every case of injury you must consider which wall of the orbit is injured. Is the injury direct or by *contre-coup?* What is its bearing upon the ball?

Chronic abscesses are associated with

PERIOSTITIS OF THE ORBIT

The symptoms of this affection are very obscure at the commencement. There is in the region of the orbit a peculiar dull pain, which is especially felt at midnight. The soft parts are congested. The other symptoms vary according to the seat of the diseased bone. When the outer angle of the orbit is affected—and this is most frequently the case, probably because this part is more exposed and liable to injury—there is pain and swelling, followed by fluctuation. The lower lid becomes œdematous, the conjunctiva is injected, and there is photophobia accompanied by febrile symptoms. The swelling bursts, and healthy pus is first discharged, and then serum. A fistulous opening is left, which leads to a denuded piece of bone.

Necrosis.—One of the bones may be necrosed, and require years for its separation, after which it must be removed. It is these necroses which give rise to ectropion (see "Ectropion").

When the disease is situated at the wall of the orbit the pus may be discharged into the sinus maxillaris, and when on the internal wall it may destroy the os unguis or the ethmoid bone, and do some mischief in that region.

Caries.—Caries of the roof of the orbit is by no means an unfrequent occurrence.

All these forms of inflammation are very acute in their attack, cause great distress and excruciating pain, and make very rapid progress. They may have their origin in one of the neighbouring cavities, run a long, protracted course, and terminate—as they, in fact, generally do—in necrosis.

The *diagnosis* will depend on whether we have to deal with a healthy subject, who has received a blow on that part, or with a person of a scrofulous or syphilitic cachexia. In the latter case the part must not be touched with an instrument.

The *treatment* must be regulated according to the condition of the patient. In a healthy subject an incision should be made into the part as soon as possible, for a timely incision, as I have just mentioned, saves suffering and the destruction of orbital tissue. In strumous or syphilitic subjects, however, constitutional treatment is mostly to be relied on—Iod. Potassium, Syrup. Iod. Ferri, and Pil. Hydr. c. Quinine. The suppuration is, at the same time, encouraged by means of poultices. The deformity of the lid must be allowed to take its course, and, after some years only, may be remedied by an operation suitable for such cases.

Foreign Bodies in the Orbit

These may be lodged in the orbit for years without interfering with vision, or even without indicating their presence by causing irritation.

Desmarres reports a case of a boy, aged 13, who fell upon a heap of wood, a piece of which, 2 cm. long, and as thick as a goose-quill, lodged in the inner angle of the orbit. It caused no uneasiness until, two years later, suppuration set in, and he then extracted it. Pieces of glass from a soda-water bottle, and such like substances, may penetrate the orbit, but they are not likely to remain quiescent for any length of time, as a piece of wood, a blunt piece of iron, and similar substances may do.

Tumours of the Orbit

Owing to the variety of tissues which enter into the composition of the orbit, this region is subject to various kinds of new formations. The bones, cellular and fibrous tissue, muscles and nerves, may all be the starting point of growths. Tumours may also invade the orbit from the neighbouring cavities.

When the tumour is situated at the summit, the eyeball protrudes, the nerves and vessels become compressed, and immediate blindness ensues; but when situated upon one of the walls, the ball is pushed in the opposite direction and vision is less interfered with, though there may be strabismus from the very first. When the tumour is in front of the orbit near the base, there is neither squint nor visual disturbance, even although it be of large dimensions.

Classification.—The old classification of tumours was into *benign* and *malignant*. The latter were said to be malignant, on account of their tendency to grow into the various neighbouring tissues and destroy them, or to set up new foci in different parts of the body by means of the blood-vessels and lymphatics. Hence there is a possibility of their recurrence at the old site, or of their being deposited in other organs. On the other hand, tumours were called benign when they were free from such tendencies. It has, however, been established by clinical experience that the minute structure of a tumour, as shown by the microscope, is not in all cases to be relied on as an evidence either for or against the probability of its return. While it is no doubt true that tumours possessing a genuine cancerous structure usually return after removal, yet cases occasionally occur in which they do not do so, and when their removal by operation proves a permanent cure. And while it is also true that tumours of a different structure are, generally, readily removable by operation without risk of recurrence, yet it sometimes happens that they do return, and prove as fatal as if they had possessed a structure with which the character of malignity is usually associated.

Virchow has completely changed our views with regard to this subject. According to him, the benign or malignant character of a tumour is not determined by the elementary constituents alone, but also by their correspondence with the mother-cells, from which they originate. The same elements have a different significance according to the tissues from which they spring. He accordingly divides tumours into *homologous* and *heterologous*. They are dangerous when they depart from the type of the mother-tissue (heterologous), or even differ from it in histological character; for instance, when they have an epithelial character, although occurring in connective tissue or cartilage. Their malignity is greater when they are very succulent and when they have a large amount of fluid in the intercellular substance, when they break down easily or when they are permeated with lymph and blood-vessels. The conditions favourable to absorption of the morbid material into the blood, and its conveyance to all parts of the system, are multiplied in proportion to the amount of soft matter in the tumour, or as the number of its lymphatics or blood-vessels increase. We have, then, irritation of the various parts, and the formation of new foci in different parts of the organism. Sometimes the blood becomes saturated with this morbific matter, and the cachexia is established.

The tumours which most frequently occur in the orbit are—

1. Fatty.
2. Cystic.
3. Sarcomatous.
4. Fibrous.
5. Osseous or cartilaginous.
6. Carcinomatous.

FATTY TUMOUR—LIPOMA OR STEOTOMA

These tumours resemble the normal fatty or adipose tissue of the body. Certain differences may, according to Paget, sometimes be found between the fat of a tumour and that of the part in which it lies, as *e.g.* the larger size of the cells of the tumour, its greater or less firmness at the same temperature, and the usual crystallizing of the margarine; but there are no greater differences than may be found in the natural fat of different parts of the same person.[1]

Fatty tumours are always invested with a capsule of a dry, fibrous, cellular tissue containing some blood-vessels. The capsule grows with the tumour and separates it from the adjacent tissues. They are elastic to the touch, and, if soft, may impart a sense of fluctuation. They grow without any pain or inflammation of the neighbouring structures.

The benign character of this tumour is so well known that I need not further dwell upon it. It usually starts from the cellular tissue of the orbit, is most frequently congenital, grows very slowly, and, when it has reached a certain size, its removal is generally called for. This is easily accomplished.

CYSTIC TUMOURS

May be found in any part of the orbit, either behind the eyeball, upon the walls, or more frequently upon the roof or floor of the orbit. They contain either—(1) Cheesy substance, (2) fatty material, (3) viscid albuminous fluid, when they are called hygroma, or (4) hair.

Fig. 115 shows the appearance of a girl of twenty-four, with a large cystic tumour. Starting from the floor of the orbit the tumour disorganized the eyeball, distended the lids, and distorted the muscles of the face. Fig. 116 shows the appearance of the patient after I had removed the tumour and a portion of the hypertrophied lid, and brought the lids together by tarsoraphia.

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[1] 'Lectures on Surgical Pathology,' ii, p. 93.

FIG. 115.

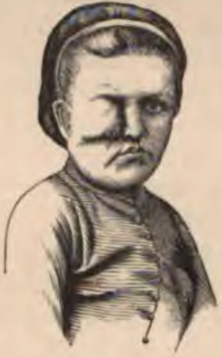
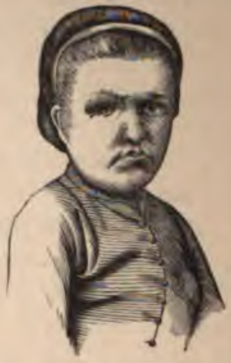


FIG. 116.



The tumour contained a mixture of curdy and albuminous substance, and a considerable quantity of coagulated blood.

Hydatids enclosed in capsules, echinococcus and cysticercus may also be found in the orbit. Cystic tumours are of ovoid shape and hard to the touch; if elastic, they may be compressible. They are slow in their progress.

LECTURE XXV

SARCOMATOUS TUMOUR

GENTLEMEN,—Sarcomatous tumours are of the most frequent occurrence in the orbit, as well as in the ocular tissues. They vary exceedingly in their appearance and are hence described as fibro-plastic, medullary, or melanotic sarcomata.

Their peculiar feature is the preponderance of the cellular elements, which consist of the connective tissue cells in a state of hypertrophy. The cells are either round, stellate, or spindle-shaped. They combine with the intercellular substance to form a relatively firm coherent structure containing vessels, and are intimately connected with the neighbouring connective tissue, thus decidedly differing from epithelial formation, and especially from cancerous tumours.

Sarcomata may acquire a medullary or, if the cells are rich in pigment, a melanotic appearance. When a sarcoma has its origin in the optic nerve or retina it may appear in the form of a glio-sarcoma. According to Virchow, the power of combination of sarcomata is very great, and not unfrequently a variety of growths may be seen in the same tumour, and the elements of sarcoma are often found along with those of cancer.[1]

Sarcomata are by no means benign tumours, their infecting power being very decided. The malignant character of sarcomata does not, however, show itself from the first. Most of them have a period of innocuousness, during which they are limited to the place of origin, and grow very slowly, often with long intermission. They may remain *in sitû* from youth upwards, or may even be congenital, not becoming malignant until maturity or old age, when they begin to increase in size very rapidly. All kinds of sarcomata are not infectious to the same extent; very hard fibrous sarcomata appear to be least so. Large-celled, especially the spindle- or giant-celled sarcomata, even when soft, are less fatal than those containing small cells. The most infectious of all is the melanotic class, which is usually merely a pigmented medullary form.

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[1] 'Die Krankhaften Geschwülste,' 1863.

Orbital sarcomata excite new foci, and are more rapidly disseminated than similar intraocular tumours, which often remain enclosed in the eye for a long time. Virchow regards the *recurrent fibroid* tumour of Paget as a variety of sarcoma.

Treatment.—Remove the tumour as soon as possible, as we are never sure how soon it may spread and infect neighbouring tissues or form new foci.

Operation for the Removal of Sarcoma.—The details of the following case will illustrate the various steps of the operation:

REMOVAL OF SARCOMA OF ORBIT WITH RECOVERY OF SIGHT

CASE.—Thomas A—, aged 8, was admitted to the Ophthalmic Institution. He was the youngest of a family of fourteen, of whom two were stillborn, two died at the ages of three and five weeks respectively, and the rest are in good health (the oldest being twenty-seven years of age). As far as could be ascertained, there was no history of cancer connected with the family. The patient had enjoyed good health until a few months prior to the date of admission, when he began to complain of debility, with languor and impaired appetite.

About three months before, a slight elevation was noticeable about the outer angle of the lower eyelid of the left side, which from this time slowly increased in size. About two months after this he was stated to have received a slight injury to this spot by a blow, and from that date the swelling rapidly increased.

When brought to me he appeared somewhat sallow and cachectic. A tumour of considerable size was situated at the lower and outer part of the left orbit, distending considerably the lower eyelid, and pressing the protruding eyeball upwards and inwards, so as to hide it completely under the er eyelid. By pulling up the upper lid he could count and see objects towards the right side.

Ophthalmoscopic examination showed the existence of engorged and protruding disc; the vessels were tortuous and much dilated. I saw him again ten days afterwards, by which time the tumour had very much increased in size, protruding itself forwards very considerably, rendering the eyelid very tense, and overlapping the eyeball. The protrusion of the eyeball was also increased. On lifting the upper lid and pushing the tumour aside, so as to expose the pupil, it was found that vision was completely abolished. The tumour was elastic to the touch, firmer on the outer side, and softer towards the centre, and presented a sharply defined border.

The tumour was removed on the 28th September, 1878, in the following manner:—An incision was made from the outer angle of the eye horizontally backwards to the extent of about three quarters of an inch, dividing all the tissues down to the bone; the lower eyelid was then everted, and the incision was prolonged forwards by dividing the conjunctiva with scissors in a line parallel to and a little above the lower margin of the orbit. By reflecting the conjunctiva the whole fore part of the tumour was thus exposed. It was enclosed in a thin but firm capsule, which was strongly adherent to the periosteum of the floor of the orbit, and in front it overlapped the margin of the orbit, so as to encroach upon the cheek. By careful dissection with the point of the knife its under surface was detached from the floor of the orbit, the detachment of its upper surface from the muscles was effected with the fingers, and the whole of it was thus removed. The edges of the wound were then brought together by two sutures, and simple dressings applied. In four days the wound was healed.

On now examining the eye it was found that vision was restored. He could read No. 5½ of Snellen's test-types. The eyeball, however, was slightly protruding, and its movements somewhat restricted, especially downwards and outwards.

Fig. 117 represents the appearance of the patient fourteen days after the operation. The horizontal slit shows the place of incision.

Fig. 118 gives the exact size of the tumour; the triangular portion (B B C) being that which lay on the floor of the orbit, the point (C) projecting backwards, and the slightly irregular line (B B) being the groove corresponding to the margin of the orbit, which it embraced. The mass (A) is the part that projected in front, pushing out the lower eyelid and overlapping the eyeball.

FIG. 117.

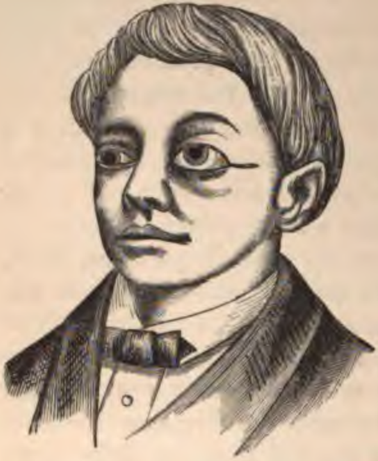
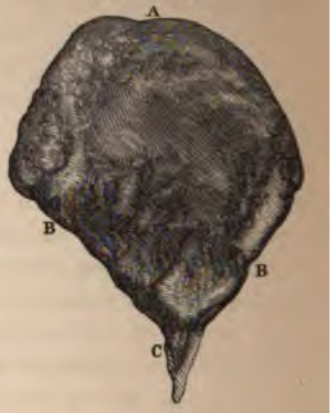


FIG. 118.



The tumour was subjected to microscopic examination by Dr Coats, whose report is as follows:

"The main constituents of the tumour are round cells, which are intimately related to a firm reticulum, such as exists in lymphatic glands. In addition to the round cells and reticulum there is a coarse, almost fibrous stroma, which intersects the tissue, and gives it an almost alveolar appearance. I regard the tumour as a sarcoma, and probably a glio-sarcoma. It might readily be taken for cancer, but I regard the existence of the fine reticulum between the cells as being absolutely conclusive against this view."

Three months afterwards I again saw the patient. By this time the protrusion of the eyeball had increased to a considerable extent, accompanied by well-marked cerebral symptoms, showing that the tumour had recurred in the back of the orbit, and had extended to the brain. Shortly afterwards the patient died.

The restoration of sight in this case was probably due to the comparatively short time during which the pressure was kept up to an injurious extent. The recurrence of the tumour is merely another illustration of the principle just referred to with regard to the character of sarcomata.

Fibrous Tumour

The structure of fibrous tumours resembles that of the radiating fibrillar connective tissue, the fibrilla being closely packed together. To the touch they are usually very firm, often exceedingly so, and may even be as hard and incompressible as hard cancer. If they are soft and fleshy or succulent it is always through œdema or inflammatory softness and inflammation of the substance. In ordinary cases they are very elastic and tense, so that their cut surfaces rise in convexities, like those of the intervertebral fibrous cartilages. In section they usually show a greyish basis substance, nearly homogeneous, and intersected with opaque, pure white bands or lines. Sometimes the basis substance tends towards yellow, brown, or blue, and the white lines are variously arranged.[1] These tumours are always surrounded by a distinct sheath of connective tissue, and are penetrated by a small number of vessels.

They are liable to various metamorphoses; sometimes cysts may form in them, at other times, again, they may undergo osseous or calcareous changes. In such cases small spicula of bone are generally found in them. Calcification is, according to Paget, an indication of a loss of formative power in the tumour. Calcified fibrous tumours probably never grow, and are as inactive as the calcified arteries of old age.

When situated at the margin of the orbit they can easily be removed, but when deep their removal becomes difficult.

Osseous and Cartilaginous Tumours

These tumours generally follow periostitis or ostitis, and are connected with a scrofulous or syphilitic diathesis, or they may have a traumatic origin. They are not accompanied with pain or inflammatory symptoms, unless periostitis coexists.

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[1] Paget, loc. cit.

Treatment.—If small, they should not be interfered with by an operation, but the treatment should be directed to the constitution. Iod. Pot., Mercury, or Syrup Iod. Ferri c. Quinine should be prescribed according to the nature of the diathesis. But when they are of large size, and cause the eyeball to protrude, they ought to be removed.

Case.—There are several cases of bony tumour on record. Maisonneuve removed an ivory exostosis in 1853, and another in 1863; of the latter case he published the following account:[1]

A boy, aged 19, was admitted to the Hotel Dieu, Paris, July 9th, 1863, for a large exophthalmos of the right eye. Only two months before admission, the patient began to be annoyed with an enlargement of his eye. There was absolutely no syphilitic history. It commenced at the inner canthus and made rapid progress; the ball was pushed right forward out of the orbit. Maisonneuve removed the tumour, August 5th, 1863, in the following manner:

The patient having been put under chloroform, he made a straight transverse incision immediately above the eyebrow, from the temple to the root of the nose, then a vertical incision upon the right side of the nasal prominence. This incision divided with one cut the whole thickness of the soft parts comprising the periosteum. This large flap he carefully dissected and laid bare the bone. This brought into view the tumour, the external surface of which he exposed without any other instrument than the point of his finger and the blunt end of the curved scissors. This denudation, however, could not be pursued very far, for the tumour was hidden in the orbit and grasped by its external walls. He tried the use of the gouge and hammer, but found that it made no impression on the tumour, which was of a veritable ivory consistence, and upon which any instrument would be blunted. Hence he determined to detach the growth *en bloc* by introducing the scissors into the deep groove which separated it from the nasal bone. It needed some violent strokes with the hammer to obtain this result, but at last the tumour moved without giving any indication of fracture of the neighbouring bone. He then seized the anterior part of the exostosis with strong forceps, trying to loosen it still further, and so draw it forwards or to make it turn upon its axis. He subsequently dislodged it by introducing the scissors on all sides in succession. Very little progress was made, but by dint of perseverance and repeated efforts, he brought the tumour sufficiently far forward to enable him to seize it with a strong tooth-forceps, and so remove it. The protruded eyeball having been replaced in the orbit, the lips of the wound were brought together by means of eight sutures. There was very little suppuration. The wound was dressed with phenic acid. The patient made a good recovery, with unimpaired vision and perfect mobility of the eyeball.

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[1] 'Annales d'Oculistique,' 1864, p. 134.

CARCINOMA—CANCER

Is a highly malignant tumour, and, as a rule, the infection soon spreads from the original focus. Bone and tendon offer but slight resistance to its attacks, so that from the eye it rapidly invades the orbit, and thence the neighbouring cavities. Metastasis usually takes place much earlier than in other heteroplasiæ. Swelling of the lymphatic glands occurs at an early stage, as these are the vehicles by which the infection is conveyed to other parts. The cachexia soon manifests itself.

The tissues of the orbit are more liable to it than the interior part of the eye. In cancer of the orbit, exophthalmos may continue a long time without the eyeball being affected. The protrusion is not necessarily proportioned to the size of the tumour, for sometimes, the wall of the orbit having been absorbed, the tumour stretches into the neighbouring cavity or into the nasal, frontal, or maxillary sinus, into the pterygoid fossa or into the cranium, and thus does not press upon the eyeball.

Treatment.—This tumour should be removed as soon as possible in order to prevent the infection of the neighbouring tissues and the development of new foci of the disease. This rule applies to all tumours of the orbit, even to approximately benign tumours when situated in accessible positions, for they may spread and branch out into inaccessible parts of the orbit, and especially because they are apt to degenerate, and it is difficult to say when that change may take place. In a case of cancer every vestige of it should be removed, and hence the section should be made in the surrounding healthy tissue. When the eyeball and the periosteum of the orbit are implicated, which is almost always the case, the former must also be removed and chloride of zinc paste[1] applied to the affected bone.

The *operation* for the removal of the eyeball in cases of cancer and all heteroplasiæ of the orbit, is not the same as for enucleation, when our object is to save soft parts. It is performed in the following manner:

The assistant separates the eyelids by means of elevators; the ball is laid hold of with forceps and strongly adducted. A strong scalpel or Beer's knife is introduced close to the outer wall of the orbit, and by one sweep carried close to the bones, the muscles are cut, and the optic nerve is then divided. The orbit having been cleaned, it must be thoroughly examined and any remaining vestiges removed. If the bones are found to be touched with the infection the paste must be applied to the spot.

With reference to these tumours, I must not omit to mention that the walls of the orbit may be greatly modified by the growths. The bones may become absorbed and considerably deformed.

Differential Diagnosis.—In all cases of tumours, therefore, you must first study their nature. Are they apparently benign or malignant or likely to degenerate?

1. Does the conjunctiva adhere to the tumour, or does it move loosely upon it? If it moves freely upon the tumour, then removal will probably be easy.

2. Where does it spring from? Does it start from the orbit or the bone, or has it extended from the brain or a neighbouring cavity?

3. Is there engorgement or varicosity of the neighbouring parts, or are the lymphatics about the neck affected? Is there severe or lancinating pain in the region? Does the patient exhibit a sickly, cancerous cachexia? These are all

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[1] ℞ Zinci Chloridi, gr. 120;
Farinæ, gr. 30;
Liq. Opii, ʒij. M.

bad symptoms. The rapidity of its development and its implicating, at an early stage, the nerves of the eyeball and impeding its mobility, are also bad indications.

Malignant tumours are more common in children than in adults. Lebert has found the largest number of malignant tumours of the orbit in children under ten years of age. *Medullary* and *melanotic* cancers are more frequently met with in the orbit than scirrhus.

ANEURISM OF THE ORBIT—PULSATING EXOPHTHALMOS

Commences with dull pain in the eye and head, with pulsation in the orbit, accompanied by noise in the ear. There is vertigo in attempting to stoop. The eye-ball gradually protrudes. Vision is affected according to the amount of dragging upon the optic nerve, and also according to the implication of the ciliary and central vessels in the general vascular dilatation. The finger when applied to the ball communicates pulsation, and the stethoscope at the orbit conveys a distinct *bruit de souffle*, like the puffing of a steam-engine, synchronous with the heart's systole. The exophthalmos progresses, the lids become distended and œdematous, the conjunctiva inflamed, and a circumscribed tumour makes its appearance. If the carotid artery on the same side is compressed the pulsation ceases and the tumour is diminished.

Causes.—This disease may be either idiopathic (true aneurism) or traumatic—caused by a blow on the ball or the orbit, or by fracture of the base of the skull. When caused by injury the aneurism may be either diffused or circumscribed, or may communicate both with an artery and vein (arterio-venous or varicose aneurism).

Seat.—It may be situated in the orbit or within the cranial cavity. Thus, the aneurism may form at the origin of the ophthalmic artery from the internal carotid, may proceed from rupture of the carotid in the cavernous sinus, or may be developed through the obstruction of the venous current within the cavernous sinus.

Travers was the first who (in 1813) recognized pulsating exophthalmos as an aneurism. He described it as an aneurism by anastomosis, and successfully treated it accordingly by deligation of the common carotid artery. He was followed by Dalrymple, who recorded another successful case (1815). Busk subsequently pointed out that these pulsating tumours were true aneurisms (1839), and this view was supported by Curling. Yet writers continued to describe it as aneurism by anastomosis, until Nunneley, who recorded four cases in his own practice, with three successes by tying the common carotid, brought the view of Busk more prominently forward, and still further developed it (1859). Nunneley regards all orbital aneurisms as either spontaneous or traumatic, and aneurisms by anastomosis as only those which spread into the orbit from a nævus of the face. The difference is not only a theoretical but also a practical one, for so long as the view that aneurism by anastomosis may be cured by deligation of the carotid remains current, operations may be undertaken with little chance of success. In the treatment of the anastomotic variety or erectile tumours, injections (lactate of iron, eight grains to the ounce) and electro-puncture are more appropriate.

Pathological anatomy has thrown very little light on this affection. Indeed, the few post-mortem sections which have been made are at variance with each other. Thus, whilst Guthrie, Caron de Villards, and Nunneley reported cases in which post-mortem examination revealed the existence of aneurism, in Bowman's case autopsy showed only tumefaction of the dura mater forming the outer wall of the cavernous sinus, and œdema and phlebitis in the interior of the cavernous, circular, and petrosal sinuses. Similar conditions were found in the cases of Morton and Oettinger. Nélaton, however, was able in two cases to diagnose during life that pulsating exophthalmos was caused by laceration of the carotid artery within the cavernous sinus, and this was verified by the post-mortem sections. Leber also has recently diagnosed the existence of laceration of the artery within the cavernous sinus, and has subsequently proved it by autopsy. To these may be added the cases of Blessig and Barron. Ernest Hart, who had a successful case by ligature of the common carotid, after failure of digital pressure, describes it as an "Arterio-venous aneurism, with cirsoid dilatation of the artery and probably also of the vein" ('The Lancet,' 1862). This description is probably applicable to the majority of cases.

Scientific opinion seems now to have veered round to the view that most cases resemble those of Nélaton. Thus, Rivington, in his lectures before the College of Surgeons of England (1875), maintains that nearly all traumatic and the greater number of idiopathic cases are due to rupture of the internal carotid within the cavernous sinus.

Aneurism of the orbit is of rare occurrence. There are only 106 cases on record in all countries; in Great Britain alone 28 cases have been recorded, of which 10 are idiopathic and 18 traumatic.[1]

The following are the details of a case which is at present under treatment, and which was recommended to me by Dr Frazer, of Kilsyth:

CASE.—Mrs. M—, aged 22, the mother of two children, of fair complexion, with blue irides, a large nævus of a claret colour on the right temple, and another on the left breast, received a blow on the left eye in February, 1881, when it became blue and the cheek swollen, but there was no pain. Three months later she began to suffer pain, with severe knocking in the head, which was very violent at intervals. She then consulted me, and I found a general dilatation of the orbital tissues, and a slight protrusion of the eyeball. There was no pulsation, but a slight bruit was audible in the orbit. Vision was not affected, and there was only slight hyperæmia of the retina without change in the vessels. On account of her expected confinement she did not return till October 11th. The eye now protrudes considerably; all the tissues of the orbit are highly vascular; the lids (especially the upper) are infiltrated and dilated. The conjunctiva is injected, and the subconjunctival tissue permeated with coarse dusky vessels. The eyeball is pressed downwards and outwards, so that adduction beyond the centre is impossible. A tumour half the size of a walnut is seen near the inner canthus. It is soft and pulsating and effaceable on pressure, when the finger is applied to the inner angle there is a distinct *bruit* like that of a telegraph wire, and the stethoscope at the orbit conveys a puffing, like that of a steam engine. The pulsation is visible at some distance, and her husband says that, when he approaches her, he hears from the eye a noise like "the clucking of a hen." When the carotid artery on the same side is compressed the bruit ceases and the tumour is partially effaced. The fundus has now assumed a distinct pathological condition: the ophthalmoscope shows a dilatation of the veins to three times their normal calibre, the arteries hardly visible, the disc cloudy and its outline veiled. The whole ophthalmoscopic appearance, in fact, approaches that of the case of Stauungs-papilla, figured in Chromo., Pl. V, fig. 2. Vision has become impaired, within the last few days ulceration of the outer margin of the cornea has commenced, and the pupil is sluggish. As she cannot read or keep her eye open even for a few seconds, telling the time on a white-dialled watch was the only test for vision I could apply; this she could only do with difficulty. Fig. 119 represents the present appearance of the case.

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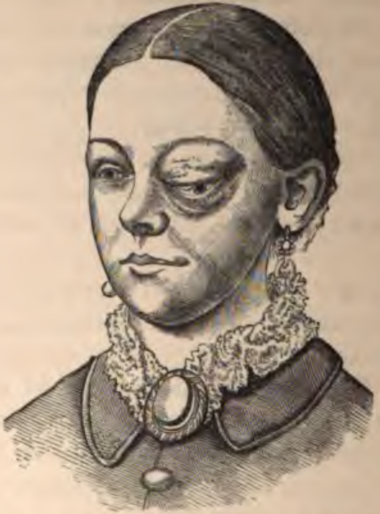
[1] See the excellent paper of Sattler in Graefe-Saemisch.

FIG. 119.



Injection of lactate of iron and electrolysis, a successful case of which has been recently reported by M. Martin, may be tried in the incipient stage of the affection, before proceeding to operative interference; but when the dilatation is general, and deterioration of vision is progressing very rapidly, time is precious, and the urgency of the case calls for more radical measures. I have therefore ordered the child, now two months old, to be weaned, after which I propose to tie the common carotid artery.[1]

DISTENSION OF THE FRONTAL SINUS

Cause.—This may be caused by suppuration within the sinus, when pent-up purulent secretion accumulates, and makes it bulge at the inner canthus. It may be mistaken for a lachrymal cyst, but may be distinguished from it, as it is larger and situated higher up than the lachrymal sac.

It may be brought on by idiopathic inflammation of the frontal sinus, but more frequently by an injury in that region. I have seen only two such cases—one idiopathic and one traumatic.

Treatment.—Make an incision upon the most prominent part of the tumour, plunge the knife into it, and explore whether there is any diseased bone; the silver probe is introduced into the nostril, and directed towards the tumour; the lachrymal dilator is then pushed through the opening made, so as to meet the probe in the nostril. A communication being thus established between the frontal sinus and the nostril, the pus is allowed to find free exit as soon as it forms. By syringing it daily with warm water, the healing process is encouraged.

These cases are very tedious, as it takes years until a cure (?) is established.

EXOPHTHALMIC GOITRE (GRAVES' DISEASE)

This curious affection is characterized by a triad of symptoms, viz. palpitation of the heart, hypertrophy of the thyroid gland, and protrusion of the eyeballs. It is generally called the disease of Basdow, but Trousseau[2] vindicated the claim of priority made in favour of Graves of Dublin. The proptosis comes on gradually, both eyes usually protruding. The patient feels as if the eyes would fall out of their sockets, and during sleep the eyeballs are scarcely protected by the lids, which, in fact, cannot cover them. The protrusion is more marked when the patient becomes excited, and in the case of females during menstruation. Sometimes there is hyperæmia of the conjunctiva and congestion at the insertion of the recti muscles. In a case which I have examined, and to which I shall refer presently, there was retinal hyperæmia, such as we sometimes meet with in presbyopia and in strained accommodation. Vision, however, is not materially compromised.

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[1] See Appendix 4.

[2] 'Clinique Médicale,' t. ii, p. 614.

The enlargement of the thyroid gland takes place gradually and imperceptibly. Generally the right lobe is more hypertrophied than the left. The isthmus may also participate in the enlargement, and the organ may reach such a size as to impede respiration, which becomes more difficult in the recumbent position. The trachea may be so compressed as to produce suffocation. The voice becomes modified, either by impeded respiration or by pressure on the recurrent laryngeal nerve.

The cardiac palpitation is violent, with a fine *bruit de souffle*, which is audible in the course of the carotid arteries and jugular veins. There is disturbance of nutrition although the appetite is perfect. Very soon sleeplessness and irascibility of temper supervene, and the speech becomes rather thick.

The three leading characteristic symptoms just enumerated, viz. proptosis, enlarged thyroid, and palpitation, do not always coexist; one or two of them may be entirely absent, when the disease is said to be *fruste*, a term used in numismatics when the superscription is effaced, and the nature of the coin has to be determined from mere traces which remain.

Medical writers used to consider this affection either as a form of heart disease or as the result of a cachexia, leading to general debility. Trousseau was the first who applied Claude Bernard's experiments to clinical researches, and suggested that the cause of exophthalmic goitre must be sought in lesion of the sympathetic—the vaso-motor nerve.

The first case published in this country, which corroborated Trousseau's theory, was by Dr Reith, and occurred in the

Aberdeen Royal Infirmary. The following is a summary of the case :[1]

"Andrew G—, aged 24, unmarried, a millworker, was admitted on November 14th, 1864. He appeared to have lived alone, and to have had his wants supplied by a neighbour, who says that he had been affected with a protrusion of the left eye as far back as he can remember, but that otherwise he had enjoyed perfect health. A few weeks ago he had an attack of what was set down as fits. He has complained for the last ten days of a pain in the head, so great on some occasions as entirely to deprive him of sleep, though of late he has been affected with sleeplessness independent of the headache. His body was well nourished, hair dark, irides blue, the left eye very much protruded, the left lower eyelid affected with ectropion, right eye normal, vision unimpaired. The following day the right eye was observed to be nearly as prominent as the left, conjunctiva of both eyes much congested, the eyeballs were motionless, and the eyelids could not cover them, pupils dilated, but no paralysis of motion or sensation in any part of the body. Hearing, articulation, and deglutition perfect. He answered questions intelligently, though slowly, and he seemed to have difficulty in recalling past events. Intelligence otherwise good."

As just stated, I had an opportunity of making an ophthalmoscopic examination, and, with the exception of retinal hyperæmia, the condition of the fundus was normal. He had complained during the previous night of a pain in the back of the head and of stiffness in the neck, which was much swollen and œdematous behind. There was also slight œdema of the ankles; pulse 100, full and regular. The carotids pulsated normally; tongue dry and brown. No eruption of any kind on the skin, which was very pure and white. There was nothing abnormal in the respiratory or circulatory system. Urine, specific gravity 1060, dark brown, transparent, strongly alkaline, giving off an ammoniacal odour and reaction when heated, no excess of uro-hæmatine, no albumen or sugar; slight deficiency of the chlorides; deep violet taint with Traumer's test. The patient died the following day.

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[1] 'Medical Times and Gazette,' 1875.

Autopsy twenty-two hours after death. Dr. Beveridge, who made the post-mortem examination, reported as follows :—Eyes very much protruded, the eyelids not closing over them; the right eye with effused coagulated blood beneath the upper lid; slight œdema of the neck behind and on the lower limbs, but no tumour noticeable; cicatrices, as from old scrofulous abscesses, under the jaw and of the left side of the neck; veins of the scalp engorged with blood, bleeding profusely when cut; veins of the diploë of the upper and back part of the cranium also gorged; frontal sinuses very large, extending over the roofs of both orbits, and separating the plates of bone there to the extent of ¼ of an inch, but otherwise healthy and containing a very small quantity of mucus; veins of the surface of the cerebrum distended, especially on the upper part of the hemispheres and on the left side; brain, firm, weighing 45 oz., studded with bloody points, especially on the left side; ventricles filled but not distended with clear serum; choroid plexus not injected; walls of the ventricle firm; pineal gland very firm and hard, but not altered in structure; its pedicle extended very conspicuously over the inner aspect of the optic thalami, and blended with the crura of the fornix, close to the corpora albicantia; cerebellum, pons, medulla oblongata, and spinal cord healthy; right orbit with veins much congested; a small quantity of half-coagulated, grumous-looking blood effused at the fore part of the orbit above the eyeball; eye and optic nerve healthy; left orbit healthy; both eyeballs at the extreme fore part of the orbits; glands of the neck somewhat enlarged, hard, but not adherent, and not pressing upon the vessels or nerves; large veins nearly empty; vasa vasorum of the large arteries finely injected, especially those of the common carotid; thyroid body about half as large again as usual, the enlargement being almost entirely produced by the lateral lobes, extending upwards by the side of the thyroid cartilage, but not pressing either backwards or outwards, and, therefore, not pressing on the vessels or nerves, and not forming any marked external tumour; mouth, larynx, trachea, pharynx, and œsophagus healthy.

Pericardium containing about three ounces of pale albuminous serum, but without any trace of disease. Heart weighed ten ounces, presenting a white spot of small size and irregular form on the fore part of the right ventricle; right cavities filled with coagulated blood; cavities and valves healthy; sympathetic nerves, of both sides, but especially of the left, large; the middle and lower cervical ganglia of the left side much enlarged, very firm, and hard; middle cervical ganglion thick, varying in width from ⅛ to ¼ inch; lowest cervical ⅞ inch long, nearly uniformly ¼ inch wide; the connecting cords correspondingly enlarged. Of the branches, those proceeding from the middle cervical to the inferior thyroid artery, and those from the lowest cervical to the temporal artery, were much more enlarged than the remainder, which varied little from the normal size. Under the microscope the ganglia seemed to be loaded with granular matter, obscuring, to a great extent, the appearance of nerve-tubes and cells, and resembling, more than anything else, the aspect of a lymphatic gland in the early stage of tubercular deposit. Dorsal, lumbar, and semilunar ganglia of nearly normal size.

On the right side the middle and lower cervical ganglia, especially the latter, were enlarged, firm, and hard, presenting appearances similar to those of the left side, but not to such an extent. The cellular tissue surrounding the ganglia of both sides was thickened and hardened.

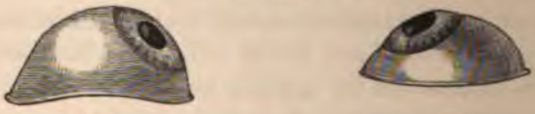
About the same time a similar post-mortem case of Graves' disease, in which cervical ganglia of the sympathetic were found diseased, was recorded in the 'Gazette des Hôpitaux,' April 16th, 1865; and Virchow has since published a list of several such cases.

The fact thus seems to be established that disease of the sympathetic produces dilatation of the vessels of the orbit, proptosis, and all the other symptoms of exophthalmic goitre, but an explanation is still required why the pupil is rather dilated than contracted. Bernard admits two sets of fibres sent out from the oculo-spinal tract of the cord, one set, the oculo-papillary, affecting the eye and the pupil, and the other vascular calorific specially affecting the blood-vessels, and that either set may be affected independently of the other. Reflex actions on the vaso-motor nerves cause a momentary contraction of the blood-vessels, which is followed by their dilatation.

ARTIFICIAL EYE.—PROTHESIS OCULI

Under enucleation of the eyeball, I have explained to yo the importance of removing only the ball, of cleaning th sclerotic of every vestige of muscular and fibrous substance and of bringing the soft parts together in such a manner a to leave a support for the movements of an artificial eye. Th wearing of an artificial eye is of great importance, not onl for correcting a deformity, but also to keep the eyelids an orbit in a healthy condition. For the lids have a tendenc to turn in, and so, the lashes rub against the conjunctiva an produce lachrymation and purulent discharge. The bones o the orbit themselves are apt to contract and become deformed This is especially the case with young people, who have los their eyes in infancy, before the bones of the orbit have bee properly developed.

FIG. 120.



Right. Left.

The artificial eye is made of light and smooth material s as to cause no friction. It must not be made too small, s that the eyelids may not contract, nor so large as to anno the person in wearing. It must be full and compatible wit comfort. The general rule is not to put in an artificial eye til about six weeks after enucleation, but in urgent cases I sometimes put it in in a fortnight, taking care, in the first instance to make it rather smaller than will ultimately be required.

To insert an artificial eye, the patient, standing before a looking-glass, must lift up the upper lid, hold the eye so tha the small point is directed to the nose and the rounder portion to the temple, and push it under the uplifted lid as fa as he can. He must then depress the lower lid and the eye falls in.

To take out an artificial eye, reverse the process. First depress the lower lid, so as to make the edge of it present itself and push gently upon the upper lid so as to make the eye come forward. For the first two or three days the removal may be difficult, and a small bird's quill may have to be introduced and used as a lever to push out the eye. Have a soft napkin ready for the eye to fall upon so that it may not be broken.

The artificial eye ought to be taken out every night, cleaned with a little warm water and dried with a soft cloth, and the orbit washed with warm water or an infusion of camomile, to keep it healthy. As soon as the enamel begins to wear off, the eye must be laid aside and a new one got, for it will then act as an irritant and cause lachrymation and discharge. A well-made artificial eye will sometimes last a year, or even longer.

LECTURE XXVI

APPENDAGES OF THE EYE

Gentlemen.—The eyeball is protected and aided in the performance of its function by its appendages, viz. the eyelids and lashes, eyebrows, and lachrymal apparatus.

The eyelids (palpebræ) are movable folds of integument, which are applied to the eyeball. We have already considered the mucous lining of the lids, which forms the conjunctival sac We have seen that it serves the purpose of lubricating the eyeball and of preserving its health and transparency. The lids, in closing upon the eyeball, protect it from the penetration of too strong light, which might be injurious to the retina; and also from foreign bodies and injurious substances.

The lids, when closed, form the palpebral fissure with two angles (canthi) at the extremities. The external canthus makes an acute angle, whilst the internal canthus leaves a kind of hollow opening. The palpebral opening, by its position in front of the eyeball, and by the nature of its integuments and the form of the orbit, imparts to the eye the various expressions characteristic of that region, which renders it an interesting study for the artist.

The free border of the upper lid is a little convex, whilst that of the lower is slightly concave. The outer end of the lid is rounded off and perforated by lashes or cilia, whilst the inner end exhibits almost a right-angled edge, on which the tarsal glands are arranged, ending in minute orifices. Near the inner angle of the lids are the puncta lachrymalia.

The eyelids are composed of complicated and heterogeneous structures. The skeleton of the lids is formed by membranes called tarsal cartilages; these, however, are only thickened connective tissue, interspersed with numerous elliptical nuclei, and form an integral part of the mucous fold, so that they cannot be completely separated by dissection. The upper tarsus is much thicker, broader, and more compact than the lower one, is crescentic in shape, with an inner acute and an outer obtuse angle. Its border towards the palpebral fissure is sharply cut off, so that it forms a surface; toward the orbital border it becomes thinned, and passes into a fascia firmly attached to the orbital margin.

The upper part of the *fascia tarso orbitalis*, or palpebral ligament, is connected with the levator palpebræ muscle, the tendon of which runs into a broad membrane, and is lost in this fascia. The fascia sends also a prolongation to each side; the inner, called the internal ligament, passes upon the lachrymal sac, and is inserted into the epiphysis of the superior maxillary bone, and the outer, known as the external ligament, is inserted into the zygomatic process of the malar bone.

The tarsal or Meibomian (sebaceous) glands are enclosed in the substance of the tarsi on the ocular surface of each lid. They are from thirty to forty in the upper and from twenty to thirty in the lower lid. They consist of nearly straight excretory tubes, each of which has numerous small cæcal appendages projecting from its side. They are seen under the conjunctiva of the lids in vertical lines, and open by minute orifices, visible to the naked eye, and sebaceous substance can be made to exude from them by pressure upon the border of the lid. This sebaceous substance is maintained in a fluid condition by the temperature of the body. It is that secretion which, uniting to the conjunctival secretion, gives rise to the formation of crusts which collect during the night in cases of conjunctivitis, and in blepharitis it unites with the mucous secretions and with the epithelial detritus, and forms hard scales.

Upon the anterior convex surface of the tarsi lies the orbicularis palpebrarum, or sphincter muscle of the eyelids. Its fibres are elliptical, and cover not only the surface of the tarsi and palpebral ligaments, but also the facial surface of the bones surrounding the orbital margin. We divide the orbicularis palpebrarum into a palpebral and an orbicular portion; to these is added a peripheral or accessory portion, which is made up of coarse, thick, dark-coloured bundles of fibres, more or less separated from each other by fat; they arise from the periosteum in the vicinity of the orbital portion, but are, however, only partially joined to this; the other part proceeds from the direction of the circular fibres, and is inserted into the adjacent integumentary portion.

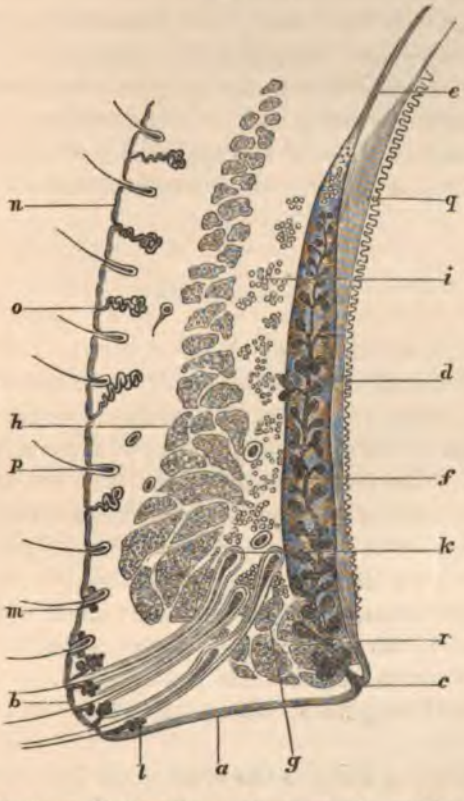
The *lachrymal* or *Horner's* muscle is considered as belonging to the orbicularis, since it, with the greater part of its fibres, really unites with the orbicularis, and thus plays the part of a separate head, and serves to keep the canaliculi in position.

Beneath the orbicularis muscle there is a structure of connective tissue interspersed with fat, which adheres to the tarsi, and is connected to the subcutaneous tissue. In this structure, near the free margin, lie the follicles of the lashes or cilia, covered by the orbicularis muscle, and surrounded by fatty tissue; their base is a line or more above the margin of the lid. A portion of the follicles rests immediately on the surface of the tarsi; another portion is somewhat more loosely connected to the submuscular layer, varying in depth and in distance from the cartilage. In each follicle, quite near the mouth, a number of racemose sebaceous glands open; their fatty contents lubricate the cilia. Tumefaction of these glands gives rise to swelling of the border of the eyelids in some forms of blepharitis.

In the immediate vicinity of the cilia numerous little hairs are found, whose follicles are also in part covered with mature sebaceous glands. The cilia undergo constant change when they have reached their normal length, which occurs within five months; their bulbs become detached while a new hair develops itself upon the papilla, which drives the old one before it until it falls out, or is loosened by rubbing, washing the face, &c.

The integument of the lid is a very delicate continuation of the common integument. It is united to the tissue beneath by loose and long-fibred connective tissue, and may be lifted up in broad folds. In the tissue beneath are numerous sudoriparous glands, and the delicate follicles of extremely fine hairs occupying the integument of the lid. The looseness of the skin renders it liable to serous infiltration, as is seen in cases of erysipelas and in panophthalmitis, the result of injury.

FIG. 121.



Upper Eyelid (from Stellwag).—*a*, free margin of the lid; *b*, outer lip, rounded off and perforated by cilia; *c*, inner lip, with canaliculus at inner angle, where is seen the racemose gland; *d*, tarsus, passing into *e*, *fascia orbitalis* or palpebral ligament; *f*, Meibomian sebaceous gland; *g*, subtarsal muscle; *h*, muscular fibres of the orbicularis; *i*, connective tissue interspersed with fat globules; *k*, follicles of lashes; *l*, sebaceous gland; *m*, little hairs near the cilia; *n*, integument of the lid; *o*, sudoriparous glands; *p*, delicate follicles of fine hairs; *q*, tarsal conjunctiva.

In old people it sometimes gets so loose as to give rise to inversion of the lids.

On the inner surface of the tarsi is the tarsal conjunctiva, indicated by its papilla, and firmly united by dense submucous connective tissue.

The *blood supply* comes from the ophthalmic artery; the two principal branches run close to the tarsus near the free border, anastomosing freely with branches of the angular, lachrymal, superficial temporal, and transverse facial. The veins empty themselves into the palpebral veins, and pass into the *vena temporalis media* and *facialis anterior*.

The orbicularis muscle is supplied by a branch from the *seventh nerve*, and acts as an antagonist to the levator palpebræ.

BLEPHARITIS

The various structures which enter into the composition of the lids may be affected primarily by an inflammatory process and tissue change, or they may be involved secondarily through inflammation of the adjacent parts, as of the conjunctiva, eyeball, bones of the orbit, or skin of the face, whence it spreads and the lids become œdematous or assume a state of chemosis, commensurate with the primary affection.

Exanthematous diseases very commonly give rise to various forms of blepharitis, involving the hair-glands and follicles, or efflorescence of the edges of the lid may be left as a residuum. In scrofulous cachexia the hair-glands may also be primarily inflamed and suppurate, when the border is studded with small abscesses.

In erysipelas of the face the eyelids get involved. There is superficial redness, œdema, chemosis, or pustules and abscesses form in the tissues of the lids, in sympathy with the gravity of the disease. When the edge is inoculated from a chancre there is proliferation of the tissues, which become swollen. The lid looks like a hypertrophied mass or like an erectile tumour, which sometimes reaches large dimensions and throws the lid altogether out of shape.

After important *operations* on the eyeball and orbit, the appearance of the lids is an indication of the state and progress of the disease. If the lids look healthy we may be sure, even without inspecting the eyeball, that the condition of the parts which have been operated on, is satisfactory, but if the borders of the lids become livid, puffy, or distended, it is an indication of some impending mischief. When, again, the swelling is subsiding it is a sign of resolution.

An acute attack of inflammation of the lid may either recede without leaving any mark behind, or the parts may be left in a hypertrophied condition, involving change of structure of the whole lid, or merely partial condensation with the formation of nodules or pustules. The parts are also liable to be left weakened and predisposed to frequently recurring attacks of swelling, styes, abscesses, or *chalazia.*

We have, then, to consider the various forms of blepharitis resulting from these and other morbid conditions.

HORDEOLUM-STYE—BLEPHARITIS TARSALIS

Is a swelling of the glands, which is filled with purulent matter, situated in the thickness of the lid beneath the integument, either in the inner or outer lip of the lid; it varies in size from a millet seed to a bean, and is roundish or oval in shape with a smooth surface somewhat elastic and hard to the touch. Its position generally corresponds to the opening of the affected gland, where it appears on the edge like a nipple, from which the purulent contents may be easily pressed out.

Cause.—Styes may be the result of catarrhal or chronic conjunctivitis, and especially after exanthematous affections, which leave behind a tendency to styes. They very rarely cause photophobia or lachrymation, but sometimes there is pain, which lasts for three or four days during the formation of the pustule, and the whole lid gets swollen. The symptoms then rapidly subside, the swelling becomes limited to the affected gland, the pus is discharged, and healing takes place very rapidly.

Styes are sometimes removed by a slow process of absorption, when they turn into *chalazia.*

Treatment.—Warm water fomentations. In cases of children with a tendency to hordeolum, I recommend mild laxatives and good nourishing food, such as cream and eggs, but no medicines.

BLEPHARITIS CILIARIS—BLEPHARITIS GLANDULARIS.

The classification of the affections of this region is variously given by different writers, and unnecessary complications have been introduced. For the sake of simplicity we may here follow the same plan which we have adopted in treating of conjunctivitis, for here also we have to do with the same disease in different stages of development.

The simplest form of the affection is the appearance upon the lid of an ichorous discharge, which dries up and leaves scales upon one or more of the lashes. The neighbouring skin is slightly red and swollen, with bluish vessels permeating its surface. The conjunctiva is generally slightly hyperæmic, sometimes considerably injected, and the Meibomian follicles inflamed. The crusts adhering to the lashes are brittle, of a pale yellow colour, and can easily be removed with a probe, when they are seen to be perforated by the cilia. The surface underneath is red.

Symptoms.—There is a feeling of stiffness in the movements of the lids, which sometimes become painful, especially in the morning, when they stick together. There is also a pricking sensation.

When the disease has existed for some time, the surface of the border may be in a raw condition and bleed at the slightest touch. This condition may remain stationary, or may be still aggravated, when the base of the cilia becomes more livid and swollen, the swelling extends deeper, involving the glands and follicles, the discharge becomes viscid, purulent, and more abundant, the whole border of the eyelid becomes red and injected, as if a red cord were drawn along it, and when the crusts are removed one or two pustules are visible underneath. As the disease progresses all the constituent parts of the eyelids participate, there is a hypersecretion of tears, and pus forms in the Meibomian glands. The secretion accumulates, the crusts become larger, the skin ulcerates, and the ulceration spreads to the integument. The lashes are twisted out of shape and present double rows in zigzag form, some being turned out, and others in upon the eyeball. Near some of the lashes are seen fistulous openings communicating with the Meibomian glands, and abscesses form in the neighbourhood. These abscesses sometimes discharge, and in other cases degenerate into caseous substance or calcareous deposits (tear stones) in the conjunctiva palpebræ, which are the product of the inflammation of the Meibomian follicles. The skin becomes contracted and the eyelids thickened and everted (ectropion). The eversion generally begins in the middle of the lid, where the tears accumulate and cause the eyelid to bulge; it then spreads and involves the rest of the lid, so that the puncta lachrymalia are not applied to the eyeball and the tears escape upon the cheek, causing excoriation of the face. During sleep the ball remains uncovered at its inferior border, and the lashes become smaller and fall off. The eye is constantly bathed in tears and presents a disagreeable appearance. During this stage the lids are covered with tenacious, adherent crusts, which conceal the ulcerations and the pustules beneath; but by pressure upon the border pus is made to exude from various points, and on removing the crusts gently the surface is found to have a worm-eaten appearance. There is a small depression surrounding most of the lashes.

Complications.—This severe form of blepharitis gives rise to a condition called tylosis (τυλος, calosity), which the French call anchovy eyes (yeux d'anchois). In this affection the border is thickened, indurated, deformed, and deprived of its lashes. So long as the eyelids alone suffer, and it passes into a chronic form, it is held to be constitutional, and cod-liver oil, chemical food, &c., are generally prescribed until the case gets worse, and, as a natural consequence of this aggravated form of the affection, the lachrymal apparatus becomes inflamed or the eyeball is involved.

Progress.—The disease may remain stationary for some time and then again assume a rapid course and degenerate into its most aggravated form.

Cause.—According to Beer, blepharitis glandio-ciliaris is a variety of catarrhal ophthalmia. Indeed, in the case of children with fair hair and fine skin, and of scrofulous cachexia, or those who live in a vitiated atmosphere and are badly nourished, an attack of conjunctivitis may leave behind a chronic condition, which, in its turn, induces glandular or ciliary blepharitis, for, in all catarrhal ophthalmia, the inflammation of the sebaceous glands spreads to the Meibomian glands, which also begin to ulcerate. It is also generally considered to be connected with a strumous cachexia, and hence is called scrofulous ophthalmia; but we meet with the disease in persons of healthy constitution and without antecedent conjunctivitis, and sometimes one eyelid alone is affected.

According to the above sketch of the affection we may adopt, for the sake of simplicity, the division into *glandular blepharitis* when the inflammation is confined to the Meibomian glands, and *blepharitis ciliaris* when the disease is situated in the hair-follicles. The disease may terminate in (*a*) loss of lashes; (*b*) trichiasis; (*c*) ectropion and epiphora; and (*d*) tylosis.

Treatment.—1. The principal thing to be attended to is cleanliness of the surface. The crusts should be removed as soon as they form, for these add to the irritation, and become a secondary cause of the ulceration. They should be softened with warm water or poultices of linseed meal, and gently removed, without irritating the tender surface.

2. The borders of the lids are then gently touched with an amalgam of nitrate of silver and nitrate of potass.

3. The borax lotion is used regularly morning and evening. The application of the amalgam is repeated every second or third day, and when the disease is in its first stage three or four applications are generally sufficient to produce a complete cure; but when the ulceration extends deeper into the integument, the pointed nitrate pencil should be applied to every ulcerated spot of the lid, and to the fistula when present, and

4. The Unguent. Flav. c. Atropia (see page 45), smeared over the edge of the diseased lid every evening. The most rebellious cases generally heal in the course of ten days or a fortnight by means of this treatment.

5. When, however, the disease has advanced to the hair-bulbs and follicles, and thus produced degeneration of that tissue, no treatment will prove availing until the diseased lashes are removed. When drawn out, each of the cilia will be found black at the point, and turned upon itself like a hook. When the lashes have been thus removed, the course of treatment just indicated will effect a speedy cure, and the lashes may be reproduced.

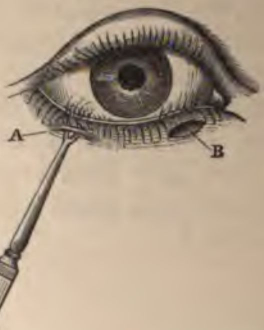
TRICHIASIS AND DISTICHIASIS

I have just mentioned that one of the results of blepharitis is trichiasis, which is a turning in of the lashes towards the conjunctival sac or towards the cornea. In it the lashes alone deviate, and the tarsi preserve their normal position, and it thus differs from entropion, in which the whole thickness of the lid is turned in. Generally only one row of lashes is deviating, but sometimes two rows are twisted from their natural position, when it is called distichiasis.

Cause.—Trichiasis is generally the result of blepharitis, but may also be caused by chronic conjunctivitis or by burns of the free border. Sometimes, however, there may be a development of a supernumerary row of hair, just as there is in some persons a supernumerary row of teeth. Trichiasis more frequently attacks the lower lid. It may be either total, extending over the whole border, or only partial, when a few lashes deviate, or it may even be only one. They may start from the proper place and take an abnormal course, or may be improperly set, starting from the conjunctival surface.

Treatment.—1. When only a few of the lashes are deviating the affection may be remedied by the following simple operation represented in Fig. 122 :—A double hook is introduced at the border of the lid through the skin A, and a fold is seized and removed by means of scissors. The oval B, along with the subjacent superficial stratum of the tarsus, represents the portion excised, which ought to correspond to the deviating

FIG. 122.



lashes; the raw edges are brought together by means of one or two sutures. This is a very simple and safe method, and ought to supersede all the systems of repeated plucking, extirpation of the hair-bulbs, cauterization, and all the diverse measures put into practice for the cure of this condition. Some of these are at the best only palliative, and others unnecessarily painful and objectionable, as being irrational modes of procedure. They only substitute another cause of irritation, viz. that of the cicatricial tissue.

An old operation, practised by Celsus and now revived by Snellen, is very useful in cases of deviation of two or three lashes. By it these lashes are made to deviate from their abnormal course. Every hair is dragged into its normal position by means of a fine silk loop, formed by both ends of the thread being left in the eye of the needle. Knapp suggested that the lash itself should be put into the eye of the needle, and thus drawn into its new position.

2. When trichiasis extends over the whole border, and is likely to resist this simple operation, the entire removal of the free border along with the hair-follicle is the only expeditious means of freeing the patient from the annoyance. I may say, however, that I have very rarely found it necessary to resort to this strong measure, for, as a rule, the removal of skin from the free border, alone or combined with an operation on the

tarsal cartilage, such as practised in cases of entropion, generally proves satisfactory.

Parasites on the lashes.—Parasites are sometimes found on these crusts. The ova of these usually give the lashes a singed appearance, which, however, is absent in some cases. Put the crusts under the microscope and you will find them alive, though in different degrees of development. They are much more common than you would expect, and that not only among those who are wanting in cleanliness, but also among cleanly and well-dressed persons. The simple reason is that they are the result of the disease of the lashes.

Treatment.—The best treatment is to touch the border with nitrate of silver, and smear it over with Unguent. Flav.

TRICHIASIS OF THE CARUNCULA

The caruncula is also liable to the development of supernumerary lashes upon its surface. Normally, these hairs are thin, pale, and visible only upon close inspection, but sometimes they are strong and black, and when well developed may give rise to chronic conjunctivitis. In every case of rebellious conjunctivitis, therefore, apply the duplex lens to the caruncula, and see whether the cause of irritation is not to be found there.

The only suitable treatment is to remove them with the cilia forceps.

ECZEMA OF THE EYELID

Is very common in connection with superficial keratitis in children. There are usually at the same time eczematous crusts at the angle of the nose and behind the ears.

Treatment.—In my experience the best treatment is to cover the eruptions with Unguent. Flav. c. Atropia (see p. 45); healing generally follows three or four days' application, and an amelioration of the keratitis takes place at the same time, but the cornea requires, on an average, about a fortnight to effect a cure, the time varying according to the depth of the corneal inflammation. I notice that the intern administration of tartar emetic is recommended by son writers, but I must speak emphatically against that syste which, I think, ought to be strictly avoided. It is and mu be treated as a local affection, arising from the irritation the cornea, or from the cutaneous irritation extending to t cornea. You see here large numbers of such cases, an witness the good effects of the simple treatment just recommended. If we were to exhibit tartar emetic and such lik substances it is to be feared that we should only induce a sickl constitution in these poor infants, and the eczema would advanc into a chronic course. It is good nourishment that suc children require.

IRREGULAR OPENING OF THE LIDS

1. Cases sometimes occur congenitally in which the eyelid are wider open than in the normal condition—*euryblepharo* (εὐρυς, wide). The external canthus looks as if a slit ha been made in the integument and in the orbicularis, and th conjunctiva is protruding. The result is irritation, watering and perhaps degeneration of the conjunctival tissue.

2. Sometimes, on the other hand, there is an opposite condition, called *blepharo-phemosis*, in which there is a congenitall narrow aperture, and a hindrance to the movements of th eyeball. It may cause strabismus and amblyopia, and i accompanied with spasm of the lids or winking.

Operation.—The operation applicable to euryblepharon i to bring the eyelids together, as in lagophthalmos, whilst i cases of phemosis a slit should be made at the outer canthu so as to make the palpebral opening correspond with that c the other eye, and to fill up the conjunctival deficiency b transplantation from the rabbit.

LAGOPHTHALMOS—HARE EYE—(OEIL DE LIÈVRE)

This condition is characterized by an impossibility to lowe the upper lid, which is shorter than normal, on account of a arrest of development. In some cases the conjunctiva, which is larger than the skin, descends, becomes inflamed, atrophies, produces xerophthalmia, and irritates the ball. It is as disagreeable an affection as absence of the lid. The disease is rarely congenital, but rather the result of granular conjunctivitis, caries of the orbit, wounds, bruises, burns, or anthrax of the upper lid. Desmarres has seen a large number of cases as the result of Adams' operation for the cure of ectropion.

Operation.—The same operation as I recommend for ectropion is applicable here (see Ectropion).

EPICANTHUS

Is an enlargement of the semilunar fold, which sometimes reaches such dimensions as to cover part of the cornea. It may be either congenital or the result of an injury or burn, or of caries of the orbit. It may be temporary, and caused by erysipelas, purulent ophthalmia, &c.

If congenital, a fold of the enlarged conjunctiva should be removed with scissors. In every case you should examine whether the lachrymal sac is affected, for generally it is connected with dacro-cystitis.

PTOSIS, OR DROOPING OF THE UPPER LID

Drooping of the upper lid is either complete or incomplete. It may be the effect of an inflammatory process, which produces elongation of the cutaneous surface, or it may be caused by a thickening of the tissues of the lid, by chronic œdema of the lid, erysipelas, hypertrophy of the connective tissue after inflammation or granulation, or too long application of a bandage; or it may be an expression of paralysis of that branch of the third nerve which supplies the levator palpebræ. You can easily distinguish between hypertrophy of the tissue and paralysis. If, on seizing a fold of the lid with the fingers, you notice that when thus relieved of its superabundant tissue, the levator palpebræ acts, you may be sure that there is no paralysis; but if the lid remains immovable, it must be owing to paralysis. Notice, also, whether the pupil is active, and whether the eyeball rotates in every direction; for in paralysis, as a rule, the other branches of the third nerve are also affected.

Treatment.—1. When the skin is relaxed and the muscle merely weakened, we endeavour to establish cutaneous and muscular action by the application of astringents.[1]

2. When this application proves unavailing the relaxed skin should be removed by the following method:—Pinch up a fold of the skin at the middle of the eyelid with forceps; the pinching causes the orbicularis to contract, and the cutaneous tissue alone is taken up by the forceps. Into this skin-fold a needle with a silk thread is introduced, and another thread at each side; then raise up the fold of skin by traction upon the threads, and order the patient to open and shut both eyes; the skin being on the stretch by means of the ligature, we measure the exact size of the flap, which we remove with scissors. It must not be too small, as that would necessitate a second operation, nor too large, or it would produce an eversion of the lid. Great attention must, therefore, be paid to the measurement of the flap and the performance of the operation, so as to leave nothing to haphazard, but to have it done accurately. The forceps, which has been invented for measuring the flap, generally leaves us in the lurch, and after the first incision we have to finish by mere guess, and, besides, obtain a raw surface with ragged edges. The stretching of the part to be removed by means of threads is a valuable contrivance for which we are indebted to Desmarres. If no subcutaneous tissue be removed there will be little oozing from the raw surface. The edges are then brought together by means of

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[1] ℞ Zinci Sulphatis, ʒj;
Aquæ Rosarum, ℥j;
Aquæ, ℥vij. M.

Or, ℞ Acidi Tannici, ʒij;
Spir. Vin, ℥j.
Apply lint dipped in the solution several times during the day.

few sutures. I generally apply four or five at the most to the whole extent of the upper lid.

Dressing consists of dry lint and bandage. The ligatures, which are of the finest silk slightly waxed, are removed on the sixth day, or may be left in longer without causing ulceration.

LECTURE XXVII

ENTROPION—INVERSION OF THE LIDS

Gentlemen,—The inversion of the lids, although apparentl a slight affection, often causes serious complications. Th friction of the lashes upon the conjunctiva and cornea produces opacity, and lays the foundation of diseases of th deeper structures, and, when there is a tendency to internal congestion, it hastens on the disease of the eyeball.

Entropion is sometimes only partial, but at other times extends to the whole free border of one lid, or even of both upper and lower. You must always regard these cases as important factors in the production of an acute or chronic ophthalmia, and proceed energetically with their treatment.

Cause.—Study the cause of the disease:

1. The skin may be relaxed, as is the case in old people (senile entropion), or the subconjunctival tissue may be hypertrophied, as in glandular blepharitis, when the border is thickened.

2. The conjunctiva may become shortened, as in granular conjunctivitis.

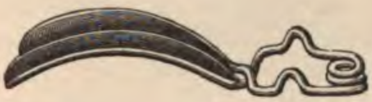
3. The border may have been injured by burns or by caustics.

4. The cause may be found in syphilitic or other disease of the tarsi.

5. The orbicularis also may become permanently contracted by long-continued photophobia, which is sometimes induced by disease of the cornea, and at other times, again (though rarely), the orbicularis becomes affected after operations on the eye. In all these cases, when entropion is once established, it will be aggravated in its progress.

Treatment.—In cases of temporary relaxation we may reduce it by closure of the lids, by merely putting on one or two serres-fines or cilia forceps (Fig. 123) upon the relaxed eyelid for a day or a few hours, or by keeping the muscle in its place by court-plaster for a short time. But in cases of permanent relaxation these simple means will be insufficient, and we must proceed to operative measures.

FIG. 123.



1. The operation already described for the cure of ptosis may also be tried in cases of entropion.

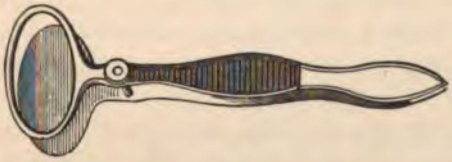
2. When entropion is caused by symblepharon, the symblepharon must be remedied by conjunctival transplantation, and then we find the entropion cured.

3. Granular conjunctivitis, when of long duration, causes incurvation of the tarsi, inducing entropion. In this case the skin operation will prove insufficient.

I need not describe all the operations which have been introduced for the cure of entropion. I may, however, mention the following:

Streatfeild's operation, in which a portion of the cartilage is removed.—"The lid is put between Desmarres' forceps (Fig. 124), the flat blade passed under the lid, and the ring fixed upon the skin, so as to make it tense and expose the edge of the lid. The incision with a scalpel is made of the desired length, just through the skin along the palpebral margin, at a distance of a line or less, so as to expose but

FIG. 124.



not to divide the roots of the lashes; and then, just beyond them, the incision is continued down to the cartilage, and the extremities of the wound are inclined towards the edge of the lid. A second incision, further from the palpebral margin, is made at once down to the cartilage in a similar direction to the first, at a distance of a line or more, and joining it at both extremities. These two incisions are then continued deeply into the cartilage in an oblique direction towards each other. With a pair of forceps the strip to be excised is seized and detached with the scalpel."[1]

The Author's Operation.—I think it, however, unnecessary, in some cases, to sacrifice any part of the skeleton of the lid, and operate as follows:

I remove an oval strip of skin 2 mm. above the border, and then make a horizontal incision among the fibres of the orbicularis, which I separate, exposing the whole extent of the tarsus. Supporting it with my index finger at its conjunctival surface, I then make a groove into the tarsus without cutting it right through. The finger held at the posterior surface of the tarsus is a guide to the depth of the incision. In bringing the skin flap together by means of ligatures the tarsus receives a slightly outward turn, so as to keep it erect. I sometimes include half the thickness of the tarsus within the sutures. Dressing consists of a simple dry compress.

Von Graefe's Operation.—Von Graefe introduced the following operation:—In spasmodic contraction of the orbicularis, where skin incision would be insufficient, he removes a portion of the orbicularis muscle. He makes, first, a horizontal incision, parallel to the edge of the lower lid, about 1⅓ mm. from its anterior margin, the extremities of the incision running up to within 1 or 2 mm. of a vertical line passing through each commissure. He then removes a triangular portion of skin (A, Fig. 125); the lateral flaps (B and C) are dissected up, and united by two or three horizontal sutures. The horizontal wound is left to cicatrize. The height and breadth of the triangle are varied according to the degree of relaxation of this portion of the lid. The height is of little consequence, but the breadth may have to vary from 3 to 5 mm. If we

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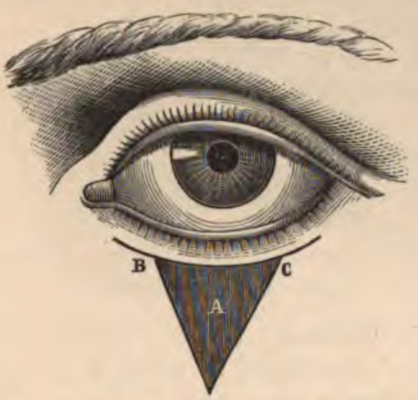
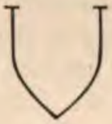
[1] 'Oph. Hosp. Rep.,' i, 121.

FIG. 125.



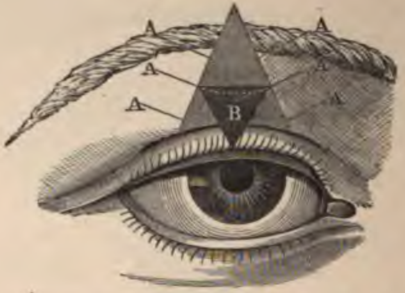
desire to gain a still more considerable effect the vertical incision may be made in the shape represented in Fig. 126.

FIG. 126.



For cases in which, together with a spasmodic contraction of the upper lid, there is also a contraction of the tarsus, he devised the operation represented in Fig. 127. After having made the horizontal incision and removed a triangular portion of the skin, he carries a horizontal incision through the fibres of the orbicularis muscle close to the edge of the lid, and pushes them up so as to expose the external surface of the tarsus, a triangular portion of which (B) is then to be removed, the position of the triangle being the reverse of that in the skin, so that the base of the triangle (varying in extent from 2½ to 3 mm.) reaches close to the upper edge of the tarsus, and its apex lies close to the margin of the lid. The whole thickness of the tarsus is removed, so that only the conjunctiva remains; the middle suture (A′ A′) should pass through the edges of the incision in the tarsus.[1]

FIG. 127.



Warlomont's Operation.—In 1874 M. Warlomont published an operation, of the success of which he speaks in very high terms.[2] He detaches the layer of the lid into which the cilia are implanted. That layer he shifts upwards, and fixes upon the tarsus. The operation is performed in the following manner:—The lid having been fixed by means of his fan-shaped blepharospath, an incision is made into the skin parallel to the ciliary border, at a distance of about 2 or 3 mm. The skin is dissected so as to expose the orbicularis muscle as far as the upper border of the tarsus. A double-edged bistoury is then introduced behind the inferior border of the wound into the ciliary border, immediately behind the row of supernumerary or deviated lashes. This detached band with the lashes is then fixed at the superior border of the tarsus. The skin flap being lifted by an assistant, some fibres of the orbicularis are excised at the level of the superior tarsus, which is thus laid bare. Four sutures are then put, which enter from without inwards, passing through the superior border of the detached band, the small fasciculus of the fibrous tissue under the tarsus, and even through a small piece of the tarsus itself. The skin is left to heal without sutures.

Lebrun's Operation.—M. Lebrun recommends the following operation:—The blepharospath having been applied, an incision is made into the skin parallel to the ciliary border, 1 or 2 mm. behind or above the point of implantation of the lashes. The incision is more or less extensive, according to the extent of the border to be corrected. The superior flap is dissected to the level of the superior border of the tarsus. From three to five needles, with strong threads, are then introduced under the conjunctiva and the orbicularis, the needles being made to graze the outer border of the tarsus until their points come out at its superior border, or even a little higher if a greater effect is to be produced. The threads are then strongly tied and the tissues strangulated. The ligatures are left in place for six or eight days. A little suppuration is produced from the cicatricial tissue, which, by its contraction, counteracts the deviation.

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[1] 'Archiv f. Oph.,' x, ii, 222.

[2] 'Annales d'Oculistique,' lxxi, i, p. 281.

If the tarsus is incurved part of it is removed; if, on the other hand, the orbicularis is at fault, a part of it may be excised.

TARSORAPHIA—SEWING TOGETHER OF THE LIDS

This operation is performed—

1. To remedy the protrusion of the eyeball in lagophthalmos and in exophthalmic goitre.

2. In paralysis of the seventh nerve, in which affection the eye-ball is exposed and unprotected, and therefore liable to be ulcerated.

3. In the operation for the cure of ectropion, in which we close the eyelids temporarily, in order to ensure the proper performance of the operation.

Tarsoraphia is performed in the following manner:—The border of the lid is laid hold of with the fingers and everted; Beer's knife is introduced through a thin layer of the free border, commencing at the middle, and carried by a sawing motion first in the one direction and then in the other, until the whole free border is pared, without touching the outer lip, where the lashes are implanted. The recommendation by some writers to remove the lashes along with the border, or to excise a strip of the conjunctiva, is needless. The thinnest paring of the flat surface of the border is quite sufficient. The upper lid having been prepared in the same manner the lids are brought together by four silk ligatures, which are left in place for five or six days, and then removed. The extent to which the lids are made to adhere will, of course, depend upon the end which we seek to attain. Thus, in paralysis of the seventh nerve, our aim being merely to afford the eyeball protection from atmospheric exposure, without excluding vision, we close the palpebral fissure only at the canthi, and leave such opening in it as corresponds with the horizontal diameter of the cornea. In lagophthalmos we close the outer or inner angle only according to the requirements of the case, whilst in operating for ectropion we must unite the eyelids through their whole extent, and keep them united until our purpose is effected.

Ectropion—Eversion of the Lids

Eversion is even more distressing than inversion of the lids. The conjunctiva is exposed and turned into a fleshy mass or is dried up; the tears run over the cheek, the eyeball is more or less exposed to atmospheric irritation and loses its glistening appearance, the cornea may become vascular and opaque or ulcerate, and the whole eyeball disorganized. Even before that stage is reached the eye has a repulsive look.

Eversion may take place in one or both lids, and may be either partial or total, *i. e.* affecting the whole border. The lower lid is more generally affected, because the upper is larger, has more range of motion, and therefore greater power of resistance than the lower lid.

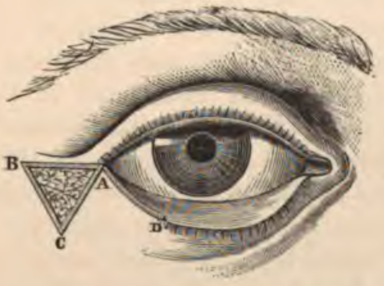
At the commencement of the disease the lid is raised from the ball, then slightly turned forwards, and gradually, by the contraction of the skin (in the case of the lower eyelid), is pulled downwards. In some cases the line of demarcation becomes altogether obliterated.

Causes.—Eversion may be caused by thickening of the conjunctiva in severe cases of infantile ophthalmia with œdema of the lids. The conjunctiva is engorged, the orbicularis becomes spasmodically contracted, and, pressing more upon the upper border of the tarsi, causes complete eversion of the lids. These temporary eversions we overcome by the application of syrup of tannin and compresses. Mechanical compression, continued for a week or a fortnight, is generally sufficient; the acute inflammation disappearing, the lids are corrected *pari passu*. Such cases, even when neglected (the lids having been left for a long time in a twisted position, the conjunctiva having become thickened by exuberant granulations), may still be cured by means of scarification, friction with tannin, and compresses. Permanent eversion of the lids is caused by glandular blepharitis, by cicatrices from the removal of tumours from the eyelids, or by loss of substance from burns, the conjunctiva looking like a continuation of the cutaneous surface. It may also be caused by caries of the bones at the margin of the orbit.

Treatment.—Operations for the cure of ectropion are very numerous, and therefore I shall only select a few as representatives, which you may modify to suit the various exigencies in your practice.

Dieffenbach's Operation.—If there is ectropion of the lower lid at the outer angle, as is most frequently the case, a triangular flap (A B C, Fig. 128), is formed, the base of which is on a level with the external commissure and 6 to 8 mm. in length. The edges of the commissure are then liberated and the lid dissected. The border of the everted lid is then pared from

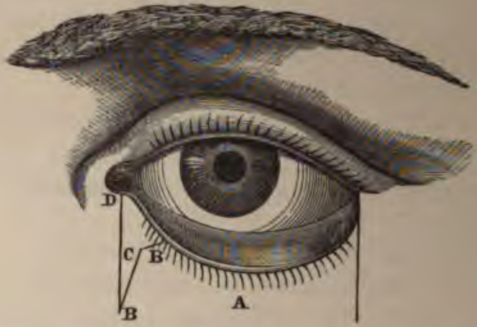
FIG. 128.



the external angle to a distance (A D) equal to the base of the detached triangle. The point A is united to B, and D to A. Twisted sutures are employed to unite the sides of the triangle, but for the palpebral borders at the base of the triangle simple ligatures are sufficient. If union is not obtained by adhesion, cure of the ectropion may be hoped for by cicatricial contraction, resulting from the removal of the triangular flap.

Von Graefe's Operation is indicated in cases of elongation of the lid as the result of blepharo-adenitis. A horizontal incision is made along the intermarginal space from the lower punctum to the external commissure. From the extremities of this incision, two vertical sections (Fig. 129), of 8 to 10 lines, are made down the cheek. The flap A is then dissected up to its whole extent and, if necessary, raised subcutaneously beyond the lower extremities of the vertical incisions. It is seized at the borders with two pairs of strong forceps, drawn towards the forehead, and maintained in this position by sutures, which are applied first to the vertical incisions, commencing at their lower extremities. As the extremities of the flap pass the angles of the lid, they are bevelled off by a bent incision (B B) with an obtuse angle (C). This angle is drawn up and united to D. The bent incision serves a double purpose, for it shortens the edge of the lid and at the same time elevates the flap. The closer C is placed to the palpebral border the less does it elevate the flap, but the more does it shorten the edge of the lid. On the other hand, the closer

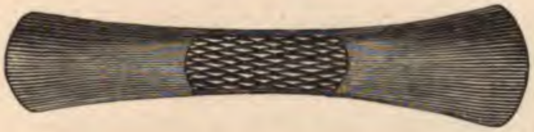
FIG. 129.



the point c lies to the vertical incision the more is the flap elevated and the less is the edge of the lid shortened. The horizontal wound is closed with sutures, which include broad portions of skin and narrow strips of conjunctiva.

Wharton Jones's Operation.—In cases in which the form of the eyelid is but little changed, and only the margin twisted, there is sometimes performed an operation usually associated with the name of Wharton Jones. As the success of this operation largely depends on the looseness of the cellular tissue, the skin is for several days previous to it moved up and down to render this tissue more yielding. If the lower lid is to be operated on, a horn spatula (Fig. 130) is inserted beneath it, so as to make it tense; two straight incisions are then made from the edge of the lid, in such a manner as to converge towards each other, and meet at such a distance below the lid that the whole of the cicatrix is included within the triangular flap thus formed. The flap is then pressed upwards, so as to bring the edge of the lid into its normal position, and all the bridles of the cellular tissue are divided, without, however, dissecting off the flap from the adjacent parts, except, perhaps, very slightly at the periphery. The edges of the wound existing below the apex of the flap are next closely united by two common or twisted sutures, and the edges of the flap on each side are also united by sutures. It is right, however, to say that Arlt's opinion of this operation is that he has never seen any satisfactory result from it.[1]

FIG. 130.



Richet's Operation.—Richet has suggested a very ingenious operation. In cases of a cicatrix at the outer margin of the lid, the result of caries, he makes three arched incisions round the orbit (Fig 131); the first is carried under the cicatrix along

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[1] 'Graefe-Saemisch Handbuch,' iii, p. 465.

Fig. 131.

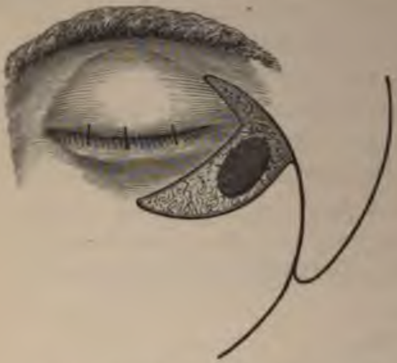
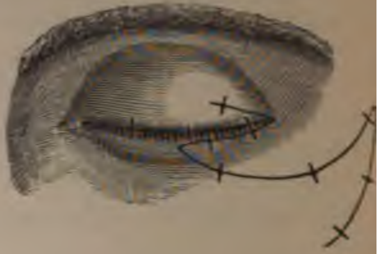


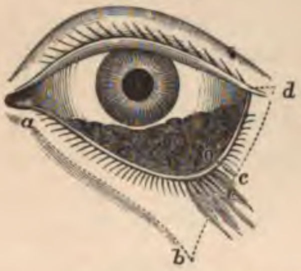
Fig. 132.



the orbital border; the second, above the cicatrix. At the temporal end of this incision he unites them by a third, in such a manner that the cicatrix is enclosed in a triangle, and the whole included is removed. The eyelid is put in its place by temporary tarsoraphia. Then he proceeds to the filling up of the gap. The incision is prolonged on one side towards the cheek, and on the other towards the upper lid, so as to form a flap. In addition to this a second flap is formed by an incision running from the union of the lower and middle thirds of the prolonged section towards the temple. The upper flap is now brought round to supply the defect, and the lower is drawn away to cover the exposed part at the temple, and to ride upon the other, so that their contractions mutually counteract each other (Fig. 132).

Arlt's Operation.—In similar cases Arlt supplies the deficiency in the following manner:—Suppose, as in Fig. 133, the cicatrix is situated at *e*, he makes two sections (*a b* and *b c*) through the skin and muscle; then he removes a breadth of 2 or 3 mm. of the border of the lid along with the lashes from *c* to *d*. The short cut (*co*) goes right through the tarsus between the lashes. He next separates the skin in the neighbourhood of the cicatrix, and loosens the triangle from *b* as far as the fascia tarso-orbitalis, so that he can easily replace the eyelid. Sometimes the fascia must be cut through. The lid is now replaced by dragging the triangular flap upwards until *c* comes to *d*. The gap then left by *a b c* is brought together by sutures.

FIG. 133.



Szymanowski proposed an operation in cases of ectropion at the external canthus. He removes a cutaneous triangle at the external commissure in such a manner that the acute angle (*a*, Fig. 134) is situated about 6 or 8 mm. above

FIG. 134.

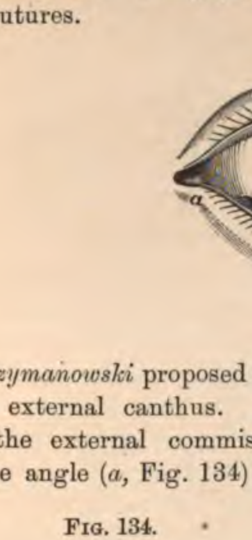
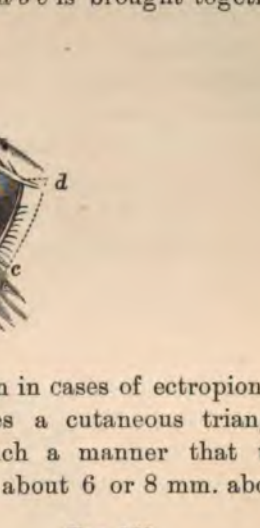


FIG. 135.

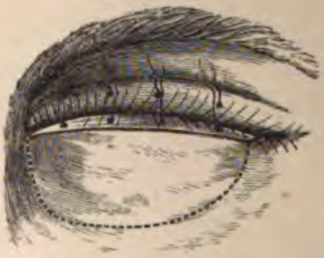


the commissure. The eyelid is then liberated by detaching the angle *b c d*, and conveying it towards the angle *a*, after having removed from the ciliary border the part between *c* and *d*. An exact union of the point *c* at *a* turns back the conjunctiva to the eyball, and corrects the eyelid. The wound of the palpebral border is then united to the side (*a f*) of the triangle, and *c b* to *a b*, as shown in Fig. 135.

Author's Method.—I have thus given you a sketch of the principal operations which are practised upon the eyelid. Some of them are highly ingenious. You will see that they are all based upon the same principle; that is to say, they all seek to spread the contraction of the part over a larger surface, and to remove substance from some adjacent part of the face to supply the deficiency of the lid.

These operations, however, have all this disadvantage, that if you cut a piece from the face to mend the lid, and the operation should prove unsuccessful, you have the reproduction of the previous state of things, plus a new facial scar. My endeavour was accordingly directed to devising a method of supplying the deficiency from another part of the body, or by skin taken from another person. I detach the adherent lid, and perform tarsoraphia (Fig. 136), clear the surface from indurated cicatricial tissue, and then cut out in a piece of lint the shape of the skin wanted. This is taken from the forearm or any other part and transferred to the lid. The figure is taken from my first case, and the dotted line shows the extent of the deficiency. The following are the details of a case which I have lately published:[1]

FIG. 136.



Mrs M—, aged 30, fell into the fire in a fainting fit, three years ago, and got her face and left eyelid severely burned; the temporal bone was laid bare; the lower eyelid was dragged downwards and outwards; the conjunctiva exposed to its *cul-de-sac;* and the lower canaliculus pulled about half an inch from its normal position. This accident not only caused a deformity of the face, but also produced dryness of the conjunctiva, especially at its outer angle, where the membrane had assumed a xerotic appearance. The eyeball was exposed, and was thus rendered liable to attacks of inflammation. Owing to the awkward twist of the eyelid, and to the total obliteration of its border, I considered the case very unpromising.

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[1] 'British Medical Journal,' March 19th, 1881.

The operation was performed in the following manner:—I began paring away the edge of the upper eyelid at the inner margin, keeping clear of the eyelashes, and opened the obliterated lower canaliculus, into which I introduced a thin probe, pushing it horizontally into the lachrymal duct. I then made a curved incision a little beyond the puckered edge of the cicatrix, and dissected up the eyelid, liberating it from the malar bone, to which it was adherent. Having introduced my finger into the conjunctival sac, to make sure that there was no puckering of the surface, and that the lid had been liberated, I pushed the probe into the nasal duct, to serve as a guide in retaining the lids in apposition, and at the same time to keep the canaliculus out of harm's way. The edge of the lower eyelid being also pared, four ligatures were introduced through the upper and lower eyelids, and tied together. The hardened subcutaneous cicatricial tissue was cleared away, and the whole extent of the gap exposed. Having taken the shape of the flap required with a piece of lint, I carefully dissected a piece of skin from the forearm, cutting it larger than necessary all round, so as to allow for shrinking; I then turned up its deep surface, and with a pair of flat sharp scissors pared off every vestige of subcutaneous tissue, so as to leave the surface of a pure white colour. It was then applied to the gap in the eyelid, to which it was united by fine silk ligatures. After pressing and moulding it into its new place, lint soaked in hot water was applied to its surface for about ten minutes. It was finally dressed with lint wrung out of hot water; over this four folds of dry lint were placed, and the whole covered with fine gutta-percha tissue, and secured by an immovable bandage. On the third day the dressing was removed, and it was found that adhesion had taken place; the flap looked clean and dry, the temperature being slightly above that of the neighbouring part.

The transferred flap looked normal; bluish lines were visible here and there. The same dressing was repeated daily. The ligatures were removed from the flap, and also from the eyelids, on the eighth day, when the flap was found to have assimilated in appearance to the neighbouring skin. Only a small inner segment of the cuticle had become slightly elevate the rest of the cuticle showed no tendency to peel off. On t fifteenth day I separated the eyelids; the lower was rat stiff at first, as if unaccustomed to its new covering and po tion, but gradually it assumed its normal appearance. Fig. 1 shows the appearance of the eyelid before the operatio Fig. 138 its condition six weeks after the operation; Fig. 1 the exact size of flap.

FIG. 137.

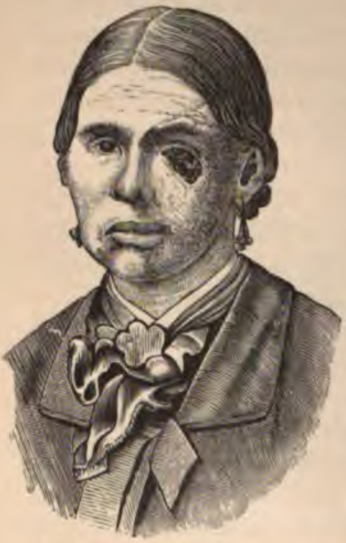


FIG. 138.

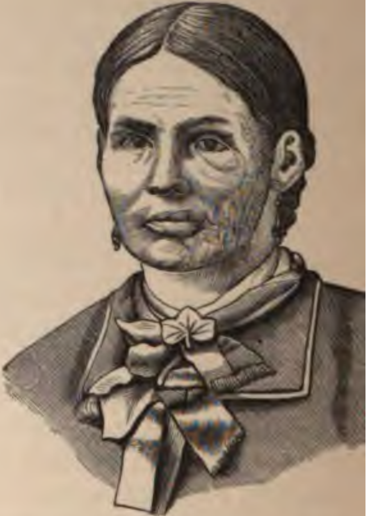
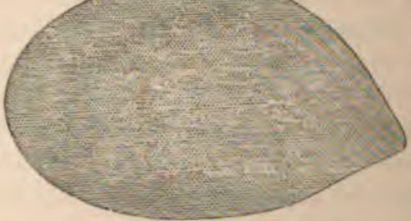


FIG. 139.



The success of the operation materially depends upon ev step being carried out in its minutest details. Seeing t such an operation takes more than an hour for its proper p formance, we shall never be able to exercise sufficient patience unless we start with the conviction that scrupulous attention in every point is essential. The eyelids should be carefully united, but not too tightly, else they will tear asunder; the wound must be properly cleared of cicatricial tissue; the size of the flap should be sufficiently large to allow a certain degree of shrinking; the forearm from which it is taken should rest in semi-supination, so that the skin may not be stretched; and the flap should be cut round the shape of lint larger than the required measure, and every vestige of its binding tissue carefully removed.

In my first operation the skin of the face was dissected all round, and served as a frame under which the new flap was inserted, and by which it was held in its place without ligatures. The dressing consisted of dry lint; but I think Dr Martin's recommendation of hot dressing is a decided improvement; and I have gradually been reconciled to the use of very fine ligatures. The patient is kept warm in bed, the head well covered, both eyelids closed, and generous diet is allowed.

This transplantation of a flap is not like the skin-grafting proposed by M. Reverdin, which is done in innumerable little bits. I have repeatedly tried this method of skin-grafting, and have found that it gives the eyelid a scurvy appearance.

My first successful case was published in the 'British Medical Journal' in September, 1875. Eight months later I exhibited the case, along with another, to the Glasgow Medico-Chirurgical Society.[1] The first case of my operation published by a *confrère*, was by Dr Wadsworth, of Boston, U.S., who exhibited it to the International Ophthalmological Congress, in New York, in 1876. Successful cases have since been reported by Professor Hirschberg.[2] Dr Martin of Cognac, Dr Vitali of Bari, Dr Agnew of New York, Dr Aub of Cincinnati, Dr Eugene Smith of Detroit, and Dr Reeve of Toronto, have published others. Two cases, by Drs Math and Pilcher, are reported in the 'Annals of Medicine and Surgery,' January, 1881. This operation formed the subject of discussion at the Amsterdam and Milan Congresses, and the surgeons who have tried it consider that "it is more satisfactory than any other blepharoplastic procedure, and is destined to supersede all others in cases where skin is wanted to replace "cicatricial tissue."

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[1] 'Medical Times and Gazette,' April, 1876.

[2] 'Beiträge für Practische Augenheilkunde.'

BLEPHAROPLASTIC

We have thus far considered only those cases in which there is a loss of cutaneous substance alone, and the skeleton of the lid is left intact. When the whole thickness of the lid has been diseased by cancer a part of the lid may have to be excised, and a flap is taken from an adjacent part to form a new eyelid. The flap may be taken from the temple, forehead, cheek, or side of the nose, according to the size and position of the cicatrix on the part to be removed. The rules to be observed in these cases are: the flap to be transplanted must be larger than the deficiency to be supplied, and must be healthy. It must be pliable, so that there may be no dragging of adjoining tissues. If there is stretching of the neighbourhood an incision must be made to liberate it from tension; the flap must be carefully applied and gentle pressure maintained. As broad a base as possible must be left.

Two different methods are in vogue—the one is the gliding method (methode par glissement), and the other the torsion method (par torsion). In the former the deficiency is supplied by substance taken from the immediate vicinity, which is loosened and allowed to glide upwards in the lower, or downwards in the upper lid. In the latter the substance is dissected off any neighbouring part and a pedicle left, which is twisted when the flap is applied. This pedicle is intended to maintain the vitality of the flap.

LOWER LID REPLACED BY A FLAP FROM THE TEMPLE

Dieffenbach's Method.—The diseased parts are comprised within two incisions, commencing at the two canthi, and converging towards the cheek (B, Fig. 140). The triangular flap is then removed, care being taken to spare the conjunctiva as much as possible. The triangular space thus left uncovered is supplied by a flap, which is made by prolonging the external commissure from A to E, which is situated about 4 mm. from the base of the triangle to be supplied. From the extremity of that incision another (E F) is made parallel to and of equal size with A B. In making this flap the subcutaneous tissue and cutaneous nerves are interfered with as little as possible, these must be included in the flap. When the bleeding has been arrested the flap is applied and adjusted as shown in Fig. 141. If the conjunctiva can possibly be

FIG. 140.

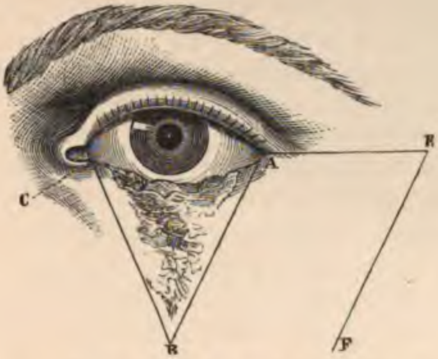
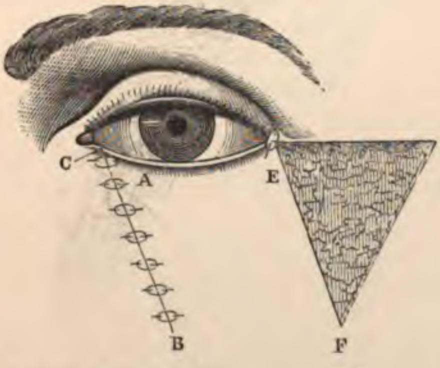


FIG. 141.

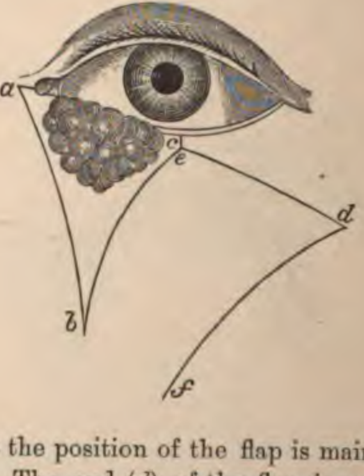


spared it must be properly joined to the new flap. Dieffenbach's advice is to leave the triangular vacancy to heal by granulation, but the disadvantage of leaving such a large cicatrix to granulate is self-evident. It not only produces a new scar on the face, but involves a dragging upon the new lid, which is likely to frustrate all our efforts. According to our present way of operating, it is best to fill up the vacant triangle by a flap from the arm.

When there is not sufficient material in the neighbourhood to supply the deficiency caused by the disease Szymanowski proposed the modification of forming the flap with an acute angle. He carries Dieffenbach's temporal incision higher up (in the same manner as in Fig. 134). The flap is thus made considerably larger, so that, even after contraction, the deficiency is easily supplied. It is also formed in such a manner that the wound can be easily united at the external angle.

Arlt's Modification.—When only half of the lid has been removed Arlt proposed the following modification:—After removing the triangle (*a b c*, Fig. 142) by slightly curved sections, the new flap is made by similar sections (*e d f*). The angle *e* is united to the angle *a*, and the internal palpebral ligament affords sufficient support to prevent the sliding of the flap downwards, but the position of the flap is maintained by horizontal sutures. The end (*d*) of the flap is united by one or

FIG. 142.



two sutures to *c*; the edge of the flap (*df*) forms the median boundary of an uncovered triangle, whose superior acute angle allows union at the temporal side, which does not drag upon the external side of the lid. When necessary, a temporary or permanent tarsoraphia would remedy that kind of ectropion.

Knapp[1] has obtained satisfactory results in a case in which he removed a cancroid tumour from the lower lid, including the edge, and extending to the inner angle of the eye. Into the healthy tissue he made straight incisions, including the tumour, which he then removed. The horizontal incisions were then prolonged towards the nose, so as to form there a square horizontal flap; the palpebral aperture was next extended by a section from the outer canthus, slightly upwards into the skin of the temple, and a second incision, at first a straight prolongation of the lower edge of the wound, curved downwards on the cheek (Fig. 143). The long flap so formed, which was considerably wider at the base, was then dissected off from the subjacent tissue, drawn forwards, and its inner angle united by twisted sutures to the vertical edge of the nasal flap. Both flaps, though rather tightly stretched, entirely covered the wound. The external fourth of the latter, still remaining in its original position, now formed the internal portion. The edges of the wound were then carefully united by numerous sutures (Fig. 144), and a compress bandage applied for forty-eight hours. Perfect union had taken place.

FIG. 143.

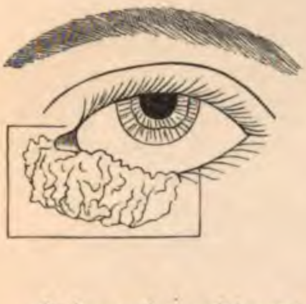
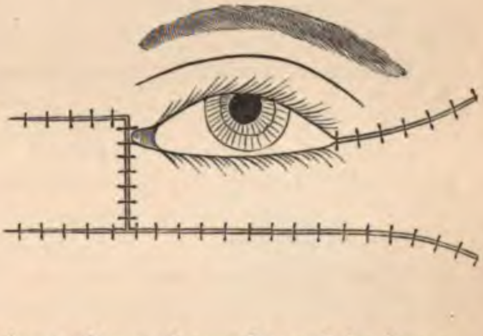


FIG. 144.



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[1] 'Arch. f. Oph.,' xiii, 2, 183.

The Torsion Method.—In this method the eyelid is formed by taking a skin flap from the forehead. It is exemplified in the operation proposed by *Blasius* (Fig. 145). After carefully removing the diseased parts the flap is marked with ink, 2 mm. larger all round than the substance wanted. The wound of the forehead is brought together by means of sutures, as shown in Fig. 146.

Fig. 145.

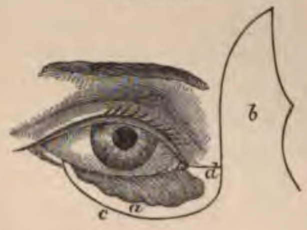
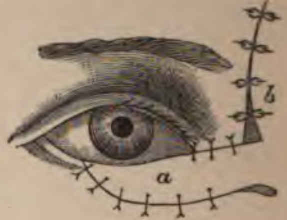


Fig. 146.



Hasner's Operation.[1]—When the loss of substance is either at the outer or inner canthus Hasner's torsion method will be most suitable. He takes a flap from the forehead or from the nose.

If situated at the inner canthus (as in Fig. 147), the diseased part is removed by two linear-curvo incisions, some millimètres beyond the diseased tissue; then a flap is taken from the nose, sufficiently large to cover the substance so laid bare. The flap is cut in such a manner that it presents, at its free

Fig. 147.

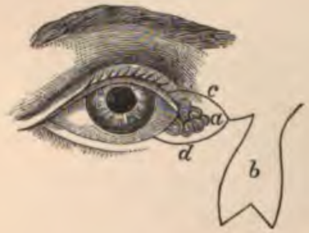
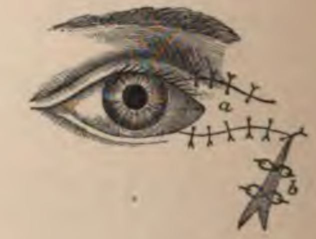


Fig. 148.



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[1] 'Entwurf einer Anatomischen Begründung der Augenheilkunde,' Prag., 1847.

border, a bifurcation, just suitable to cover both ends of the lids, as seen in Fig. 148.

Arlt thinks this operation of great practical value in its application to cases of epithelioma, which is generally situated at the inner canthus.

When the external commissure is diseased the procedure is the same, except that the flap is taken from the temple. When the ends of both lids are affected a flap is taken from the forehead and cheek.

I have only one remark to make with regard to plastic operations in cases in which the whole or part of the skeleton of the lid has been lost by disease or removed by the surgeon for a heteroplasia: I think that the operation *par glissement* from the immmediate neighbourhood has the best chance of success. The original rule laid down by Tagliacozzi is that the flap must retain connection with the adjacent living structures by a pedicle, which is to be severed only after complete union and cicatrization of the new surfaces. It appears to me that there is no proof of the soundness of this principle, on the contrary, the pedicle has been a source of great embarrassment to surgeons. I can never see how a twisted pedicle can promote the life of a transplanted flap. I think, therefore, that you will in practice find that those blepharoplastic operations will yield the most satisfactory results in which the neighbouring part of the cheek is drawn up, and the vacant space supplied by a flap taken from the arm or some other part. You will also find that the chance of success diminishes with the increased size of the transplanted flap. The smaller the flap the more probability is there of its retaining its vitality. Hence Knapp's method of taking one flap from each side is the most likely to succeed. I think it also advisable, in these cases, not to separate the lids very soon, but to leave them together for some months.

LECTURE XXVIII

BLEPHAROSPASM

GENTLEMEN,—Spasm of the orbicularis may be either tonic or clonic.

Tonic spasm, in which the eyeball is tightly grasped by the lids, is synonymous with photophobia, and is present in phlyctenular keratitis, or even in some forms of conjunctivitis. It may be caused by the impaction of a foreign body or a tear-stone in the conjunctival sac. I have already explained to you that photophobia is an expression of the irritation of the fifth nerve in any of its ramifications. You must therefore look at the mouth, teeth, velum palati, and see if there is any ulcer there, or some indurated cicatrix involving the fifth nerve.

Clonic spasm is manifested by winking or nictitation, *i. e.* constant opening and shutting of the lids, without an interval of rest to enable you to get a right view of the eyeball. It is a disagreeable affection, not only to those who are subject to it, but sometimes even more so to the onlooker. But if the patient has any anomaly of refraction, and can wear spectacles, they to some extent hide the peculiarity. There is generally winking in both eyes. I find these cases frequently associated with a high degree of myopia, with capsular cataract, and with amblyopia. At other times, again, it is found in nervous and hysterical subjects, or may be associated with chorea or tick of the face. It is sometimes permanent, and at other times intermittent, and brought on by excitement.

Von Graefe first pointed out[1] that, as the disease is mostly caused by reflex action of the fifth nerve, the convulsive attack may be corrected by pressure upon the supra-orbital nerve. In some cases the patients themselves are instinctively led to press upon the brow with a hat or ribbon, in order to arrest the convulsive movement.

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[1] 'Lehrbuch der Nervenkrankheiten der Menschen,' 1853, p. 350.

Treatment.—Remove the cause of the irritation. In constitutional affections tonics, cold douch, hypodermic injection of morphia, and galvanism may be tried. In one case de Wecker performed a section of the supra-orbital nerve. From what we know of the effects of neurotomies in epileptiform neuralgia I should think that, in order to be of permanent effect, a part of the nerve must be removed, otherwise the cut nerve reunites, and the previous state of matters is reproduced.

Paralysis of the Seventh Nerve

The facial nerve consists of two distinct parts, viz. the facial (*portio dura*) and the auditory (*portio mollis*). Both enter the internal auditory meatus in the temporal bone, but soon separate from each other. Within the temporal bone the facial is connected with several other nerves by separate branches, and immediately after issuing from the stylomastoid foramen it gives off three small branches, viz. the *posterior auricular*, the *digastric*, and the *stylo-hyoid*. It is then continued forwards through the substance of the parotid gland, and separates in the gland behind the ramus of the lower maxilla into the *temporo-facial* and the *cervico-facial*, from which branches are given off to form the *pes anserinus*. This network gives off two branches—one to the upper and one to the lower half of the orbicularis muscle.

One of the effects of paralysis of the portio dura is inability to close the lids. When both upper and lower lids are affected they remain open, but more widely at the inner angle than at the outer. The levator palpebræ will contract spasmodically, in consequence of the insufficiency of its antagonist.

Paralysis may be complete or incomplete. In complete paralysis, when of long standing, the eyeball acquires the habit of rolling upwards, and during sleep remains exposed. This exposure leads to disease of the ocular tissues.

Cause.—The cause is the same as in disease of the other cranial nerves, viz. cold after being heated, producing periostitis, and compressing the nerve in the stylo-mastoid foramen. The same effect is produced by syphilis, or may be the result of injury.

Treatment.—We may administer Iod. Potassium and apply blisters to the temple, use mercurial ointment, and galvanism when the affection is slight or due to a cause which is likely to pass off by a short course of internal treatment; the eyelid does not call for any attention. But if the case is severe, and the ball is considerably exposed, on consideration that it is a protracted disease, taking months and sometimes years to improve, and that meanwhile the eyeball may suffer by exposure, a tarsoraphia must be performed, as described above.

CHALAZION

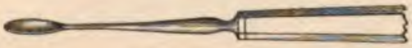
Chalazion (χαλαζιον, hailstone), or Meibomian cyst, is a small indolent tumour of the lid, more frequently occurring on the upper lid, and varying in size from that of a millet seed to that of a bean. It is transparent or reddish, and of fibroplastic elements. In its centre there is frequently found a small cyst, coming from a Meibomian gland. It is generally situated at the border of the lid.

Patients tell us they "have been troubled with a stye, which has fallen into the lid." This is, in most cases, a correct account of its origin, but sometimes they are situated higher up in the lid, and grow independently. Indeed, there may be a whole cluster of them. Chalazia may be situated in front of the tarsus, immediately behind the orbicularis, or behind the tarsus, causing an elevation upon the conjunctiva palpebræ. When situated externally they are half spherical, but when internally are flattened, and do not show much on the surface, but their size may be seen on everting the eyelid; or they may belong partly to both classes, *i. e.* they may be situated partly in front of and partly behind the tarsus. This is generally the case when they are situated at the free border of the lid. They may be either adherent to the tarsus, even to such an extent as to twist it slightly, or may be free and movable under the cellular tissue.

Sometimes the chalazion remains of small size for a long time, and does not give any annoyance; at other times it grows and suppurates, after which the tumour may shrink or become the starting-point of a new chalazion.

Treatment.—When very small and softish it may be dispersed by warm fomentations and friction with Unguent. Hydr.; but when it is large and indurated it is best to remove it. When it is situated externally and of moderate size, I seize the lid with my left hand, and, supporting the tumour from behind with the thumb, make an incision into the skin and orbicularis, which I separate. I press the tumour forward; if it be movable, it will thus be entirely removed; but if adherent to the tarsus, a small curette (Fig. 149) is introduced behind the fibres of the orbicularis, and by means of it the residuum is cleared away. The skin is either left to heal of itself or brought together with one suture.

FIG. 149.

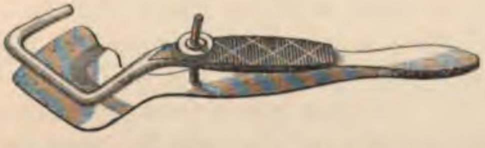


When the chalazion is situated behind the tarsus I evert the lid and cut down upon the conjunctiva, and then, by pressing with the thumb from behind, it is expelled.

When it is of a mixed form I introduce small scissors into the conjunctiva and cut it off at the point of adhesion.

In cases of large chalazia Desmarres' lid forceps (Fig. 124) or Snellen's (Fig. 150) is of great value, as it serves as a hæmostat, and the tumour may thus be dissected out without

FIG. 150.



the embarrassment of hæmorrhage. The fingers are the best instruments for the removal of a small tumour. When it is situated near the upper border of the tarsus I push it upwards and remove it through the conjunctiva.

Dermoid Cysts of the Lid

In connection with these small growths I may mention dermoid cysts, which are of frequent occurrence on the lids. When you remove such a cyst you will find it enclosed in an envelope, and on holding it between you and the light you will see hair covering the inner wall of the capsule. When you perforate it, and squeeze out the contents, cheesy matter mixed with hair escapes from it. With regard to the removal of these tumours, the rule is to take them out clean, and with the capsule unperforated.

Herpes Frontalis

I have already mentioned that this disease is caused by the reflex action from deep perturbation of the fifth nerve. In studying the ramifications of the trigeminus, the cutaneous affection can be traced back to its true source.

Epithelioma of the Lid

Is more generally situated at the inner canthus. The patients who are thus affected are old people. A wart is noticed growing at the inner angle of the eye, and though it does not annoy the patient at first, it gets itchy, so that he cannot help picking at it. A dry scab then grows upon its surface. On removal of the scab a red, slightly elevated and indurated spot, is visible underneath. A new scab forms, under cover of which the induration spreads over a wider surface and extends more deeply into the tissues. By and by this indurated spot begins to ulcerate, and its surface becomes moist with ichorous discharge, and bleeds slightly; the scabs get thicker and softer. If unchecked, the disease increases both in depth and extent, and involves both lids or even the eyeball.

Treatment.—Speedy removal of the growth is the only course of treatment. When the epithelioma is small I remove it with the knife. An incision is made into the neighbouring healthy skin, so as to make sure that no vestige of the diseased part remains behind. The bleeding is arrested and the surface is dressed with carbolised wadding.

When the disease is extensive, I prefer removing the diseased part by means of caustic arrows.[1] Several punctures are made in the healthy skin round the tumour and the arrow introduced into the wound. The neighbouring parts are protected from the caustic by means of a piece of leather, which is so shaped as to surround the arrows closely. The whole diseased mass is eliminated in a few days, when the surface is dressed with carbolised wadding.[2]

These epithelial cancers sometimes extend to the eyeball. Some years ago I operated, along with Professor Macleod, on the following:

Case.—Mr A. G—, from Girvan, had an epithelial cancer at the inner canthus, and had had it removed by Professor Syme. The disease returned and spread to the eyeball, after which Professor Syme refused to interfere. The patient carried this growth for upwards of two years, when it involved the eyeball and upper lid and became very painful. I removed the ball, amputated the lid, and dressed it with carbolised wadding. The wound healed satisfactorily, the parts contracted and did not look so badly as one would have expected. The patient, who was otherwise a robust person, lived six years after the operation, when he died from disease of the liver, but there was no return of the epithelioma.

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[1] ℞ Zinci chloridi, ℥j;
Wheat flour, ℥iij.

Add water to form a stiff paste, divide into thin flattened points an inch and upwards in length, and about the thickness of brown paper, and tapering from $\frac{1}{8}$ to $\frac{1}{4}$ inch down to a point.

[2] I read a paper on the subject at the meeting of the British Medical Association at Oxford in 1868.

Nævus

Nævi of the eyelid are usually congenital. There is at first a small rosy spot, which may extend and become a large vascular tumour in the skin, or it may involve the whole thickness of the lid. It sometimes assumes large dimensions and overhangs the eyeball.

Treatment.—Small nævi may be got rid of by hot needles being introduced into them. I have succeeded in removing several such by these means, but when they are of large dimensions I use the galvanic cautery, by which the vascularity is shrivelled up, and they may then be removed like hypertrophied masses.

Wounds and Tears of the Eyelid

These only call for special attention when the whole thickness has been cut through and separated. It is not sufficient to bring the integument together, but three strong ligatures must be carried through the middle of the cut edges of the tarsus and carefully brought together. Healing is very satisfactory.

Xanthelasma Palpebrarum

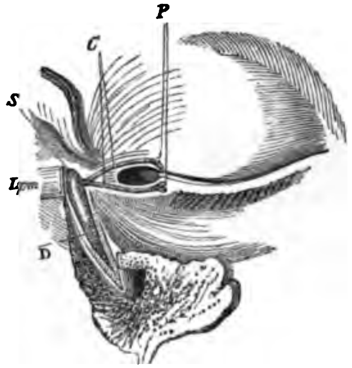
This is a buff or yellow-coloured patch of the skin, which occurs at the inner angle of the lids. It appears in middle-aged persons, and are, according to Addison, associated with disease of the liver.

They are harmless patches, require no treatment, and should be left alone.

THE LACHRYMAL APPARATUS

The lachrymal apparatus consists of the following parts, viz. the lachrymal gland with its secretory ducts, the small canals (canaliculi) into which the fluid is received, and the sac with the nasal duct, through which the tears pass into the inferior meatus of the nose. The lachrymal gland, which is analogous to the salivary glands, is situated partly in the cavity of the orbit, at the superior and external border in the lachrymal fossa, and partly in the thickness of the lid. The position of the gland is such that, when the upper lid is entirely removed, only its lower border is seen, the rest of it being hid in the fossa lachrymalis. The secretory ducts of the gland, eight or ten in number, open into the *cul-de-sac,* at the side of the upper lid. The tears, after having lubricated the surface of the eyeball, are conveyed into the nares by the lachrymal passages (Fig. 151).

FIG. 151.[1]



P, puncta lachrymalia; *C*, canaliculi; *S*, sac; *D*, duct; *Lpm*, ligamentum palpebrale mediale, cut short at the commencement of the sac.

On the margin of the lids, near the inner angle, there are two small elevations (papillæ). Each papilla is perforated by a small aperture (punctum lachrymale), and at these apertures commence the small canals, which convey the tears from the eye to the lachrymal sac. The two openings look backwards, and lie with their points close upon the lateral part of the plica semilunaris. The puncta lead into the superior and inferior canaliculi, the direction of which is at first perpendicular to the border of the lid, but, after penetrating 1 mm. in depth, they take a direction towards the inner canthus with convex curves, the upper with its convexity upwards, and the lower with its convexity downwards.

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[1] From Merkel, in 'Graefe-Saemisch.'

The passage consists of lamellar epithelium, of a basement and proper membrane, of the fibres of the orbicularis muscle, which covers it in like a mantle, and of the skin; these are all so thin that a dark probe, when introduced into the canaliculi, is quite visible.

The lachrymal sac fills up the lachrymal fossa, and is, like the nasal duct, lined by ciliated epithelium. Various valves have been described in the tear passages, one at the vertical part of each canaliculus near the punctum, a second at the deep orifice of the canaliculus, and a third formed of mucous membrane of the nose, and overhanging the inferior orifice of the nasal duct. Their existence, however, is by no means established, and it is at least certain that they are not of constant occurrence.

I have already mentioned (p. 32) that a portion of the tears is secreted by the conjunctiva itself. After lubricating the eyeball the tears are partly evaporated and partly absorbed by the puncta, which are closely applied upon the globe, and conveyed by the tear passages into the posterior nares.

DISEASES OF THE LACHRYMAL APPARATUS—EPIPHORA, OR HYPERSECRETION OF TEARS

This may be sympathetic by irritation of the lashes, conjunctiva, or cornea, by dacrolithes, or by irritation of the tear-passage itself. These are all common occurrences, the result of the anatomical relations of the parts, for the lachrymal nerve is a branch of the first division of the trigeminus, which, after supplying the gland, sends ramifications to the conjunctiva, orbicularis, and skin of the upper lid. Hence, any irritation of any of these parts will reflect upon the gland, and cause a flow of tears. It may also be caused by eversion of the lid and deviation of the punctum. The punctum may be closed by inflammation, or may even be congenitally absent. Further, there may be stricture, either simple narrowing or complete closure of the canaliculi, with inflammation, or as the result of previously existing inflammation. Sometimes we find ulceration of the canal in trying to introduce a probe. We meet with a false passage, as if some violence had been done to the canal by the introduction of instruments. The stricture may be situated at the point of junction of the canaliculi with the sac, at the junction of the lachrymal sac with the nasal sac, or at the opening of the nasal duct into the nose.

In rare cases the irritation is situated in the mucous lining of the nose, and is caused by polypus of the Schneiderian membrane: but these cases require no special consideration here. There is, however, a form of epiphora, the cause of which is obscure. We seek in vain for its exciting cause; it is not to be found in any of the tissues just enumerated, and, in fact, no reason whatever can be assigned for it. We can only suspect that it may be caused by some irritation in the gland itself, and it baffles all therapeutic measures. Zachariah Lawrence reported good results from the removal of the lachrymal gland. Abadi is also in favour of that operation, and thinks it not to be so dangerous as is generally supposed.

Operation.—The upper lid, along with the integument of the brow, is strongly pulled down, and an incision is made at the outer angle of the orbit, close to the margin; the lower border of the gland is then seen, and the dissection for its removal facilitated. For my own part I share the opinion of the generality of surgeons, that the inconvenience of a weeping eye is not to be exchanged for the risk of that operation, as I think every operation within the cellular tissue of the orbit a hazardous one, and not to be practised unless in undoubted cases of disease of the gland.

DACROCYSTITIS

This may be either *acute* or *chronic*. *Acute* inflammation of the lachrymal sac is not of such frequent occurrence as the chronic form. It commences with a disagreeable feeling in the inner canthus; there is epiphora and dryness of the nostrils, the pain becomes more severe in the region of the sac, and then a small swelling, hard and sensitive to the touch, becomes visible at the inner angle. From this the swelling spreads to the integument of the nose, cheek, and eyelid, and looks like erysipelas of the face. The eye soon participates in the disease, the conjunctiva and plica semilunaris become inflamed, and the cornea itself may also suffer; the sac becomes largely distended. It may be accompanied with febrile symptoms, and there is a feeling of throbbing at the inner angle. By and by it comes to a point in the middle, and then pus is discharged, which is first thick, then thin, and mixed with tears and mucus.

I said that these cases are less frequent, for more generally they run a *chronic* course. At first it commences with a slight uneasiness at the inner angle. The patient feels that the tears run down the cheek in cold or windy weather. After this state, which may last for months, the flow of tears is constant, and he has to dry up the tears several times a day. In the course of time a thick mucous discharge comes out, which again changes into a purulent secretion, and, if neglected, the disease may progress and gradually distend the lachrymal sac, till it reaches the size of a large bean in the inner angle. This condition may last for years without any other inconvenience, except that three or four times a day the patient has to squeeze out matter from the sac. As a rule, they assume frequent acute inflammatory processes. During one of these attacks the abscess bursts, the sac is opened, and a fistula lachrymalis is established. This fistula is generally of capillary size, but each time that the patient presses the matter out part of it comes through the fistula, and part through the upper punctum. It is a very troublesome and tedious affection, and is not only a deformity and a constant annoyance, but may give rise to frequent attacks of conjunctivitis, and endanger the deep structures of the eye.

Whenever, therefore, a patient complains of a watery eye, put your finger upon the sac, and see whether there is any regurgitation of tears or mucu-purulent secretion in one or both puncta. More frequently the lower punctum is closed, and the secretion comes from the upper. Put the lower lid upon the stretch by drawing upon it at the outer canthus, evert the inner angle, and see if the puncta are visible. Introduce a fine probe to discover whether the canaliculi are patent or not. If they are, then the stricture must be at the deeper part of the passage. Now introduce the dilator (Fig. 152) as far as the edge of the bone, and then withdraw it; this widens the canal, and enables you to insert No. 1 or 2 of Bowman's bougies, which is pushed gently into the nostrils. The easy passage of the bougie or the resistance it meets with at certain points conveys to you all the necessary information with regard to the condition of the passage, and the treatment must be regulated accordingly.

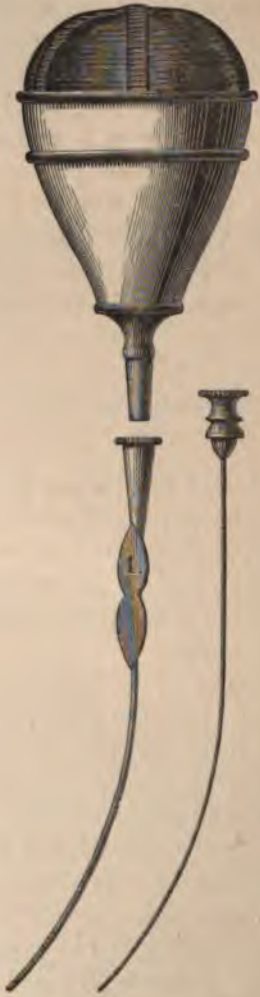
Fig. 152.

Treatment.—1. In cases of acute dacrocystitis I introduce No. 1 of Bowman's sounds into the canal, push it right into the nares, and leave it there for two or three hours. Hot poultices to the part are generally sufficient to arrest the violent inflammation. Many an acute attack is thus cut short. If suppuration has already commenced, and the abscess burst, leaving the bougie in the canal for two hours every day causes the perforation to close.

2. If the punctum is awanting or obliterated, I put the lid on the stretch, evert it, and with a broad needle I enter the place where the punctum ought to be, and introduce a bougie, which I push into the nares. In cases of stricture I introduce the dilator. This makes way for the subsequent introduction of the sound. A few days are generally suffi-

cient to effect a cure. Fig. 153 *c* is No. 6, which I hardly ever use, No. 3 being usually sufficient.

FIG. 153.



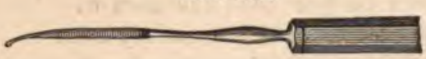
a, hollow catheter with syringe; *b*, its rod; *c*, bougie No. 6.

3. If a slight mucous discharge has already commenced,

and I think it necessary to wash out the canal, I introduce de Wecker's hollow catheters (Fig. 153 *a*). To these I have added an elastic syringe, which fits into them, and may be removed at pleasure and refilled, so that the water is injected without withdrawing the instrument. The whole canal is thus thoroughly washed out.

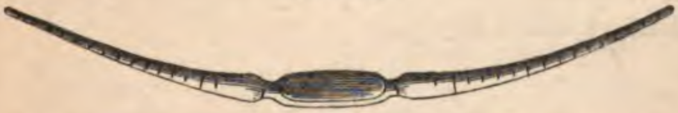
4. If the stricture is situated at the junction of the canaliculus with the sac, I introduce the sound through the upper canaliculus, which is generally patent, into the sac, and leave it there. I then introduce another bougie (No. 1) into the lower canaliculus, and try to touch the sound in the upper canaliculus. If this can be done by withdrawing the one from the upper canal I generally succeed in introducing the second. But if I find the stricture complete I introduce Weber's knife (Fig. 154), with its edge towards the conjunctival *cul-de-sac*. When the probe-point arrives at the edge of the bone the knife cuts its way into the sac, and a free passage is thus made for the introduction of a larger sound, which is kept in for one or two hours a day, until the healing process is established.

FIG. 154.



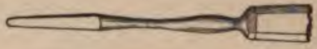
5. For cases of stricture existing at the junction of the lachrymal sac with the nasal duct Stilling devised an operation called stricturotomy. He first inserts Weber's conical sound (Fig. 155) to ascertain the position of the stricture and dilate the passage. The sound having been withdrawn he introduces the knife (Fig. 156), and incises the stricture in different places, until the blade can be turned freely in every direction. The canal is then washed out in the usual way.

FIG. 155.



Slitting open the Canaliculi. — Since Mr Bowman first pointed out the fact that the lachrymal canaliculi, after having been laid open down to the caruncula, and transformed into

FIG. 156.



an open canal, do still continue to carry off the tears, it is to be feared that the practice of slitting open both canaliculi has been carried too far. You are taught in text-books that when a patient complains of a watery eye, the first thing you have to do is to slit up both (!) canaliculi, and examine where the stricture lies. Now we can obtain this information by simply introducing the bougie. Long before Mr Bowman made that suggestion the lower canaliculus used to be slit open, and this operation I still practise in the following cases:

a. When there is ulceration or false passages in its course, and I have reason to fear that the cure will be a long and tedious process, and the patient cannot conveniently remain under treatment for a sufficient length of time, I open the lower canaliculus by introducing one blade of small scissors, directing it obliquely towards the caruncula. The lips of the wound are kept open by means of a probe until there is no chance of their uniting.

b. When there is deviation of the punctum which cannot be corrected by treatment, no harm is done by turning the canal into an open one.

c. When the sac is diseased to such an extent that the introduction of porte-caustic is necessary, as this is impracticable through the canal, slitting open may be resorted to.

In every other case the tear-passage ought to be spared and maintained in its integrity.

DACROCYSTITIS, CHRONIC

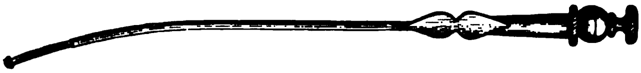
Treatment—These are the cases we are most frequently called upon to deal with, and are always very troublesome and tedious. The best course is to try dilatation and washing out of the passage:

a. When the sac is dilated add an olive-shaped piece of india rubber, sewed in lint, and applied to the tumour to act as a compress, and kept in position by means of a bandage.

b. When the case proves obstinate I inject it with Zinci Sulph.—not nitrate of silver, for it regurgitates and injures the conjunctiva.

c. I devised an instrument (Fig. 157) for the sac, on the same principle as Lallemand's porte-caustic for the urethra. This is introduced into the sac; by turning the button the caustic comes in contact with the whole surface of the sac and touches it all round.

FIG. 157.



d. Professor Hirschberg suggested to me a very simple method of cauterization, viz. by means of *caustic bougies.*[1] Cauterization, however, cannot be practised without slitting open the canaliculus.

Encysted Lachrymal Tumour.—Sometimes, in cases of large and hard tumours bulging outwards at the inner angle, pressure does not cause regurgitation at the canaliculi, and a sound introduced into the sac slips easily in by the side of it, and is arrested at the nasal duct. What has taken place here is this: the pus is encysted in the sac, which has distended the orbicularis and skin. In these cases I introduce the pointed dilator as far as the sac, press with my finger upon the tumour, pushing it backwards, and thus puncture it. The pus is then discharged through the canaliculi, and the sac evacuated; the passage is then syringed out every day with warm water, and bandage and compress applied, which the patient must wear constantly for a week or a fortnight, until the parts assume their healthy function.

Disease of the Bony Canal and long-protracted Epiphora.—This is a still more tedious affection, and continues for years.

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[1] A D violin string three inches long, coated one third of its length with nitrate of silver, is introduced into the sac.

In treating the tear-passage by means of sounds and cauterisation you must proceed cautiously and gently. There has lately been introduced a practice called *forcible dilatation* of the passage by means of thick bougies, and quite appropriately so named, for considerable force must be applied to push such lumps of metal through the passage. These instruments seem to be very popular just now, but I would warn you against their use, as I fear they may have a tendency to lead, not only to hypertrophy of the sac, but also to periostitis, which is a most tedious and distressing affection.

Periostitis is sometimes associated with *ozæna*, or bad smell from the nostrils, which the French call *punaisie* (resembling bugs). The only remedy is patience and syringing with warm water. Trousseau recommends a snuff made of calomel and sugar.[1] This is a useful remedy, you may use it alternately with syringing, with borax, bichloride, and other astringent solutions.

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[1] ℞ Calomelanos, ℥j;
Sacchari albi, ℥iss.
Misce bene. Use three times a day.

APPENDIX

I

Case 1, of extraction of both lenses, recorded (p. 158) as resulting in perfect restoration of vision in both eyes.

In the first eye operated on, the tough capsule, with white, chalky-looking specks upon it, has again closed. I have lacerated it, on the 19th October, 1881, but the result is not yet known.

II

Case 1, of injury of the ciliary region (p. 243), recorded as resulting in total loss of vision.

When an injury causes a gaping wound, there may be softness of the eyeball before the wound closes, with subsequent return of normal tension. This is exactly what has taken place in this case. The lens, however, gradually became opaque, but on its removal perfect vision was restored.

III

Case 2, of Glaucoma fulminans, recorded on p. 270, cured by paracentesis and iridectomy.

I had an opportunity of testing the acuity of vision in this eye five months after the operation. The patient can read brilliant type with perfect ease; the ophthalmoscope shows no trace of disease of the fundus, and the field of vision, as ascertained by the perimeter, is normal.

IV

Aneurism of the Orbit

Case, recorded (p. 381).

November 16th, 1881.—Wishing to give the antiseptic treatment a trial in this case, I allowed Dr Foulis on the 20th

October to perform the operation. The artery was tied with a catgut ligature under the spray, and the Listerian method strictly followed, both during the operation and in the subsequent dressings. Pulsation in the orbit ceased, the tumour was considerably diminished, the eyeball retracted within the orbit to such an extent that motion in every direction was perfect. Vision is now normal (she can see the seconds pointer on the watch), the ophthalmoscopic appearance shows clear definition of the disc, and the blood-vessels are nearly of normal calibre, though the veins still present considerable tortuosity at the periphery. Up to date there has been no bad symptom, the patient has slept well, and the temperature has never risen above 100°.

Dr Macleod, Professor of Surgery in the University of Glasgow, examined the patient with me, fifteen days after the operation, and we found her in a most satisfactory condition. She was then regarded as convalescent.

When the stethoscope is applied to the brow a slight puffing sound is still audible, but the patient is not conscious of it, and there is no pulsation. As four weeks have now elapsed, and the eye is gradually receding within the orbit, the cure may be considered perfect. She is to be discharged to-morrow as cured.

I may take this opportunity of saying, apart altogether from the merits of antiseptic surgery, that the introduction of the catgut ligature, in a form to render it safe for tying large arteries is itself a great achievement.

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